(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL.

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J. S. BONSALL, Business Manager.
F. H. THOMPSON, Eastern Representative

R. V. WRIGHT, } Editors.
E. A. AVERILL, }

SEPTEMBER, 1909

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up a full head of steam under difficult conditions and that is really the prime requisite. The demand for a stoker comes from the same source as the demand for other improvements on locomotives, *i. e.*, increase of capacity. There are large numbers of locomotives now in more or less successful operation on which the average fireman can keep up full boiler pressure at the beginning of his run with comparative ease, but often has great difficulty in doing so toward the end of the division when he becomes physically tired and the fire gets into a bad condition. Possibly the tubes begin to leak and other things are to his disadvantage. On such runs as this a reliable stoker will be greatly welcomed. On the monstrous Mallets, however, where it is practically impossible for one fireman to handle enough coal to keep up a full head of steam for more than an hour or so, the use of a stoker is imperative.

While it is hardly safe to say that the stoker is beyond the experimental stage it certainly looks as if it was rapidly developing and that probably within the next year the experience will be sufficient to prove its entire reliability under ordinary conditions.

JOY VALVE GEAR.

The Joy type of valve gear is and has been for a long time the standard type on the Lancashire & Yorkshire Railroad in England and is now in operation on over 1,000 locomotives. It is also used to a much smaller extent on some other English roads and has been tried on the continent. With the exception of the Lancashire & Yorkshire it seems that other roads have found, after trial, that its disadvantages are sufficient to at least not make it as popular as the Stephenson or Walschaert. For locomotives with inside cylinders having independent valve gears however, it would seem that the Joy gear was particularly adaptable, inasmuch as it requires no connection and obtains no motion directly from the crank or axle. It has been adopted by Mr. Taylor for use on the inside cylinder of his three-cylinder Atlantic type locomotive and is evidently well suited for that design. It has also been adopted for use on the engine of the White steam automobile, where it is reported to be very successful.

The Joy gear is of the radial type to which the Walschaert and Baker-Pilliod designs belong and like them it gives a constant lead. It gives a very rapid motion to the valve when opening and closing and considerable less compression at short cut-off than does the link motion. Its greatest disadvantage is probably in the opportunity for wear between the block and the link and these parts have to be made with great care and with ample surface. We give elsewhere in this issue a descriptive article of two designs which are now in successful service on English locomotives.

A DIAGRAM OF LOCOMOTIVE CHARACTERISTICS.

In the October, 1907, issue of this journal, page 389, there was presented an article by Lawford H. Fry giving a most interesting and valuable diagram consisting of a series of characteristic curves covering the whole range of operation of a high speed balanced compound locomotive, by means of which a most thorough and accurate investigation could be made of the proportions of any locomotive of this type. In the November, 1908, issue, page 417, a similar series of curves were given for single expansion locomotives. By means of these characteristics a rapid determination can be made of almost any desired feature in connection with the operation of the locomotive under any assumed condition. These curves show that the B. D. factor (tractive effort multiplied by diameter of drivers divided by total heating surface) is proportional to the number of foot-pounds of work developed per square foot of heating surface during each revolution when the engine is working at full power, and in this issue is given another article by Mr. Fry in which is included a diagram for determining this factor with any combination of heating surface, cylinder dimensions and boiler pressure.

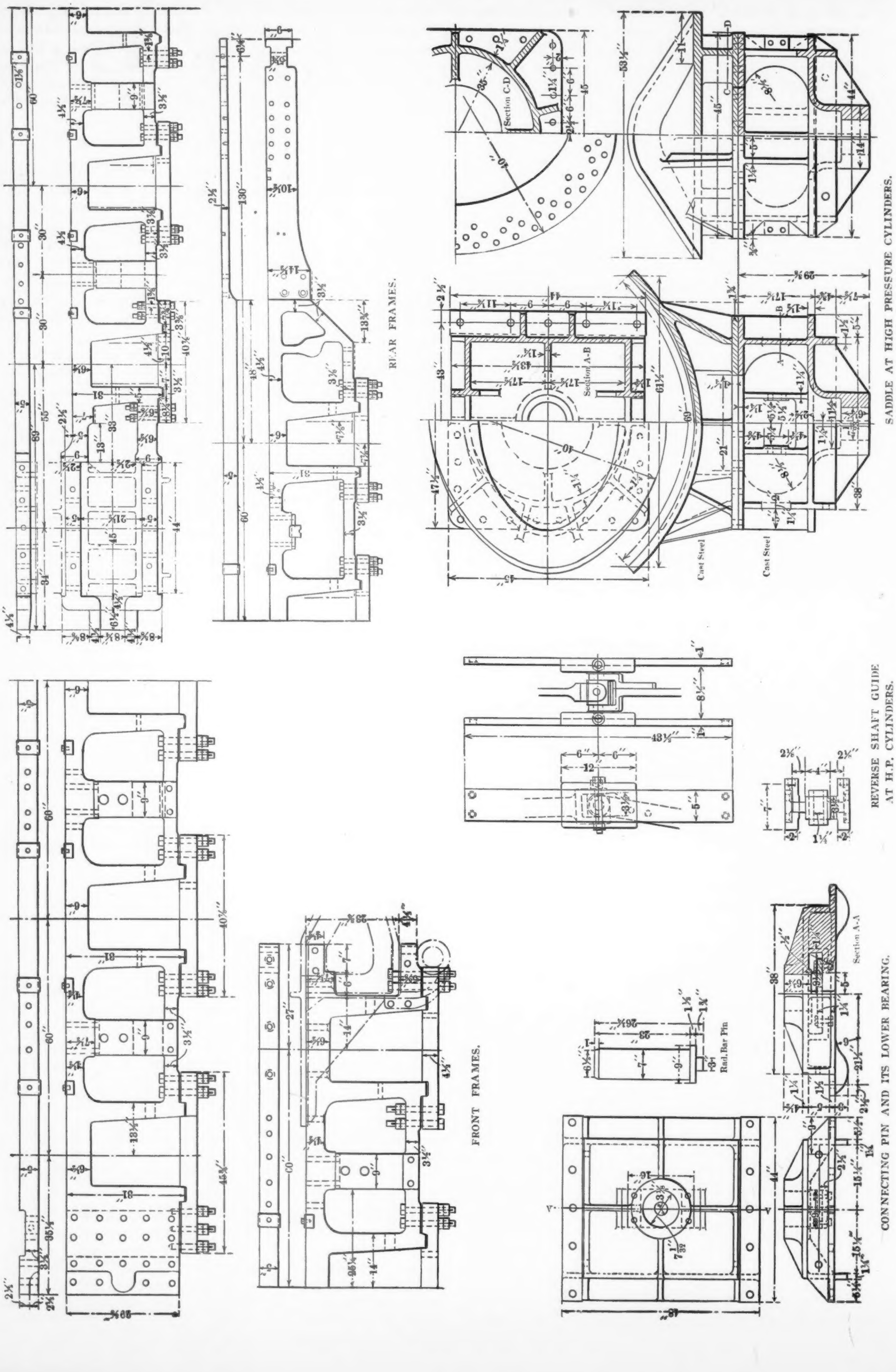
This chart, we believe, will be found to be of considerable value in developing a new design or in investigating a present one and we are arranging to furnish copies of the diagram, printed on heavy paper, to any one wishing them, for ten cents a copy.

RAILROAD CLUBS.

It is pretty generally admitted that the railroad clubs as a rule are not accomplishing the results which they should and of which they are easily capable. The cause of this condition of affairs cannot be laid at the door of any one in particular, nor can it be corrected by any one acting alone. The secretaries of most clubs are given practically full control of the conduct of affairs and are expected to accomplish impossible results unaided. In their efforts to keep up the interest and increase the activities of the club they find a most decided disinclination of members to furnish papers and a most disheartening ignorance of the contents of the paper by the few who get up in the meeting to discuss it. The latter condition is, however, oftentime not the fault of a member wishing to speak, who has received his copy of the paper but a day or so before, nor is it the fault of the secretary, who at the last moment was thrown down on the paper that he had arranged for and had to get something on short notice to fill in with. The position of secretary of a railroad club is by no means an easy one and they are deserving of all credit for accomplishing as much as they have, although it is really, in the final analysis, but a small part of what should be gained. If the full benefit possible from the railroad club is to be gained by the members and incidentally their employers, it will be necessary for every one to do his share. The secretaries can accomplish the result if they are actively backed by the members, individually, and only then.

President Vaughan in his address before the M. M. Association this year suggested that the railroad clubs should perform a large part of the detail work which the large association now attempts to do and finds impossible because of shortness of the time. He suggested that the subjects which will come before the association in June be submitted to the different clubs, and that a full and general discussion, taking into consideration the local conditions in each part of the country, can thus be obtained. When the subject is then taken up by the M. M. Association it will be possible to rapidly come to a sensible conclusion. Somewhat of the same idea was expressed about a year ago in these columns by L. H. Turner in a letter in which he said: "I have had a hobby for some years, but so far have been unsuccessful in getting any one to ride it but myself, to the effect that the railroad clubs of the United States should appoint a joint committee on subjects, and that each club should discuss the same subject the same month that the other clubs are handling it; if you can get five or six of the best clubs discussing the same subject at the same time, with a membership of anywhere from four to six thousand, and the members as a class taking an active interest, it is safe to assume that there will be very little left of the subject which would not be thoroughly threshed out by the time the reports were all in, and I believe that were five or six of the best clubs to take up any particular subject, that the findings of the whole would be very valuable to any railroad interested in that particular subject."

It is certainly to be hoped that some action along this line will be taken and that it be started as soon as possible. The railroad club secretaries already have an association which would seem to be the natural place for a movement of this kind to be developed. There are enough subjects coming up for discussion at the next June conventions to keep the railroad clubs busy all the winter and if the secretaries of the different clubs will get together and see that each of them cover as much as possible of this list of subjects there is no doubt but what their work will be appreciated by the M. M. and M. C. B. Associations as well as by their members. The secretaries, however, can't write the papers and do all of the discussing. The members must each do his share.



REAR FRAMES.

FRONT FRAMES.

SADDLE AT HIGH PRESSURE CYLINDERS.

REVERSE SHAFT GUIDE AT H.P. CYLINDERS.

CONNECTING PIN AND ITS LOWER BEARING.

DETAILS OF SOUTHERN PACIFIC MALLET.

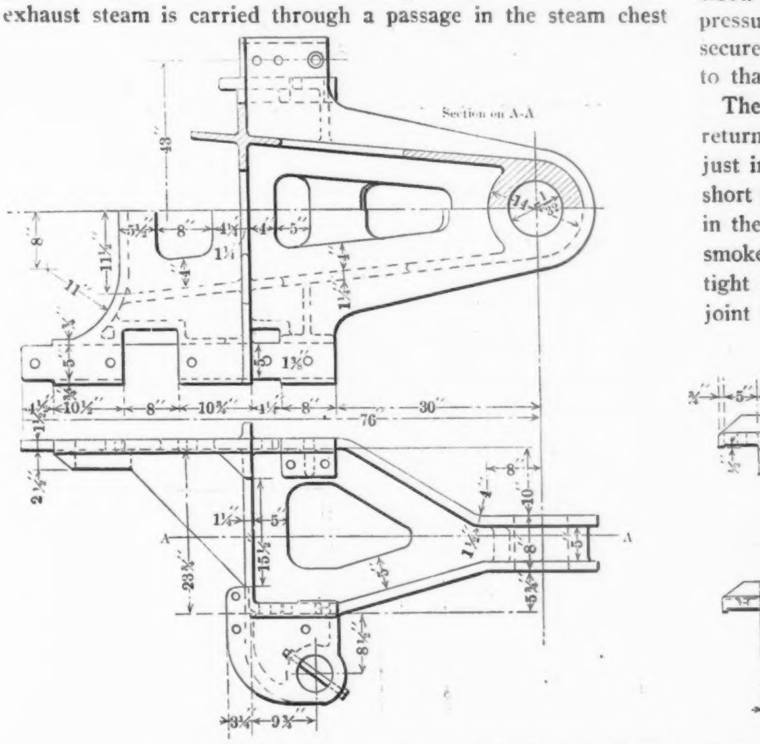
MALLET ARTICULATED COMPOUND LOCOMOTIVE

SOUTHERN PACIFIC COMPANY.

(*Continued from page* 181, *May issue.*)

In the former article was given a general description and a number of illustrations of this locomotive and of its very interesting boiler, which includes a feed water heater and re-heater. In this section there will be described a few of the more interesting details and reference should be made to the former article for a general description.

Cylinders.—The high pressure cylinders, with their valve chambers, are cast separately and without a saddle, being supported entirely by the frames of the rear group, which have two front rails. They are secured by keys in front and are bolted to the frame rails both vertically and horizontally through flanges on the casting. Since in this design the steam at boiler pressure is brought to the top of the valve chamber through an outside pipe and the exhaust from the high pressure cylinders is carried forward on either side by pipes secured to the boiler shell, there are no steam passages leading between the frames. The high pressure cylinders are 26 in. in diameter and are not provided with bushings. The walls are 1½ in. thick and the heads are of cast steel. Fifteen inch piston valves with inside admission are used, the valve chamber bushing being ⅝ of an inch thick. The admission ports are 1½ in. wide and the exhaust ports 3 in. in width. The exhaust steam is carried through a passage in the steam chest



CONNECTING HINGE CASTING ATTACHED TO FRONT FRAMES.

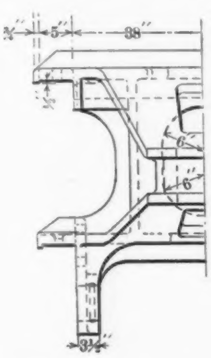
back of the valve chamber to a 6 in. opening in the center at the top, to which the pipes leading forward are connected by ball joints. The walls of the steam chest are normally 1¼ in. thick and the center of the valve is set 4½ in. outside of the center of the cylinder. The relief or drifting valves of the Sheedy type consist very simply of a 5 in. passage cored in the casting back of and between the valve chamber and cylinder, having a connection at either end to the cylinder steam port. At either end of this passage is a valve held open by a spring, which is easily compressed and the valve closed when steam is admitted to the cylinder. It remains open when the steam is shut off and gives a free passage from one end of the cylinder to the other.

Eight-inch exhaust pipes are carried forward along the boiler shell from the H. P. cylinder to the front end of the reheater in the smoke box. These pipes are fitted with a slip joint near their connection to the cylinder, which will allow for expansion and also give a disconnecting joint when the front section of boiler with the front group of wheels is to be removed, a joint in the boiler shell being provided at the combustion chamber for this purpose.

The low pressure cylinders, 40 in. in diameter, are also cast separate and are bolted to a box casting, which is secured to the forward end of the frames. They are of the same general design as the high pressure and have 15 in. piston valves with inside admission. The walls of the cylinder are 1⅝ in. thick at the thinnest part. The ports in the valve bushing are of the same width as in the high pressure. The heads are cast steel deeply dished and ribbed, as are also the piston heads which have a cast iron bull ring forming the bearing surface and seat for the packing rings.

The box casting between the low pressure cylinders is of cast steel and massive in design. It has a bearing of 21½ in. in length and 29¾ in. in depth on the slab section of the front set of frames, to which it is secured by 20 1½ in. bolts and held in line by a recess 1½ in. deep and 8¾ in. wide in the frames. The cylinders are set into a recess in this casting 2 in. in depth and are locked in place by a wedge at the front end and secured by 22 1½ in. bolts. A steam passage is cored in the casting, the connection from the re-heater being brought to it by a flexible pipe which will be mentioned later, connecting on the back face at about the center line. From this point a 9 in. diameter passage is carried forward and dividing at the center line of the cylinder emerges at the top on either side and is continued by a short elbow pipe with ground joints to the steam passage of the low pressure valve chamber. A massive cast steel bumper plate is secured ahead of this box casting, the connection being similar to that at the frames.

The exhaust from these cylinders is discharged into a double return pipe or tee connecting on the front side of each cylinder just inside of the valve chest and joined on the center line to a short pipe having a full ball joint on the forward end, a slip joint in the center and a flexible ground joint at its connection to the smoke box and exhaust pipe. The slip joint in this pipe is held tight by means of snap rings and leakage grooves. The ball joint in the forward end is the same type as those on the steam type, shown in one of the illustrations. The flexible joint at the smoke box is of the ball and socket type and is held to its seat by a coil spring.



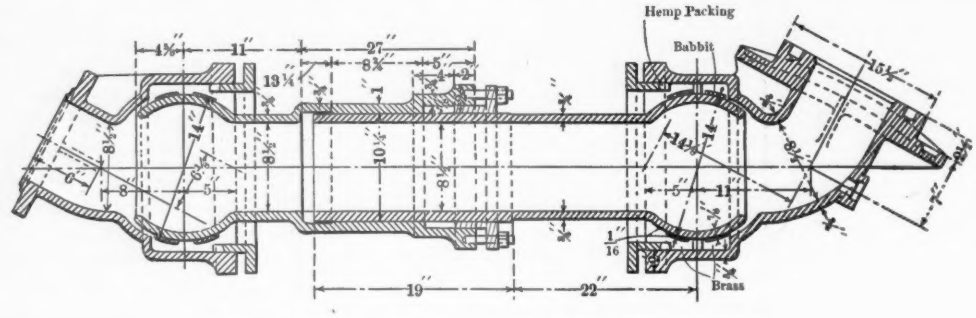
The design of the steam pipes for conveying the steam from the re-heater to the steam passage in the box casting, is clearly shown in the illustration. It has a full ball joint at either end and a slip joint in the center, the latter being packed with hemp packing.

The valve gear is of the Walschaert type, being arranged so that one gear will balance the other, *i. e.*, for go-ahead motion the radius bar is down on the forward valve gear and at the top of the link for the rear gear. The general arrangement of the valve gear is shown in the illustration on page 182 (May issue).

Articulated Connection.—The connection between the two groups of wheels is made by one bar, which is hinged on a 7 in. pin located between the high pressure cylinders, 57 in. back of the center of the rear axle of the front group of wheels and 55 in. ahead of the front axle of the rear group. The steel castings forming the hinged joint are shown in the illustrations. The one attached to the front group of frames is most substantial and has a bearing of 46 in. in length on the top rail and 13½ in. on the bottom rail, to which it is secured by 1⅜ in. bolts. It is cored out and made as light as consistent with the desired strength and stiffness. The connection to the rear set of frames is made by a saddle casting riveted to the boiler shell and bolted to the top rails of the frames between the high pressure cylinders. Below this and forming the lower bearing for the pin is a frame cross tie secured to the bottom frame rails.

The pin is inserted from below and is held in position by a plate below it setting into a recess in the bottom casting. The design of this is clearly shown in the illustration.

Frames.—The frames are of the usual bar type 5 in. in width and 6 in. deep over the pedestal, except the front pedestal of each group, which is 6½ in. in depth and the rear pedestal of the forward group which has the same dimensions. The pedestal binders are of the usual type held in place by bolts passing through the bottom rail. The front frames terminate in a slab section, which is secured to the box casting as mentioned above. The rear group of frames terminate in a 2½ x 10½ in. slab section, which forms a trailer truck frame, but is integral with the main frames. The frames on one of these locomotives were made of vanadium steel to the same dimensions as those shown in the illustrations.



FLEXIBLE STEAM CONNECTION TO LOW PRESSURE CYLINDERS.

Centering Device.—The weight coming on the front group of wheels is transferred to them at two points, one being located under the center of the combustion chamber 87 in. ahead of the center of the fulcrum pin and the other 61 in. in front of this or 148 in. ahead of the articulated connection. Both of these supports are, of course, of the sliding type, permitting the front group of wheels to move horizontally in relation to the boiler. The support at the combustion chamber consists of a cast steel saddle bolted to the shell and a steel box casting secured on top of the frame. Between these is a renewable cast iron bearing plate. The forward support is of the same general type, its saddle, however, being riveted to the boiler shell and it contains a spring centering device to bring the front group of wheels into alignment after passing through a curve. This arrangement is practically the same as was applied by these builders to the Great Northern locomotives of this type. The frame cross tie or bottom bearing is extended out on either side and carries two brackets at its outer end. These brackets carry a 1⅝ in. rod which passes through cored passages in the saddle casting and has four large washers, the inner two being secured to the rod and the outer two being free to move inward but prevented from outward movement. These outer washers take a bearing on the inside of the outer walls of the saddle casting. Between the two washers is a heavy coiled spring put in under slight tension. The operation of the device is as follows: When the front frames move sidewise relative to the boiler in taking a curve, they carry with them the rod and the spring on the inside of the curve is compressed, the outer washer bearing against the saddle wall and remaining stationary while the rod slips through it and the washer on the opposite end of the spring secured to the rod compresses the spring. The spring on the other side is simply carried inward between its washers without compression.

The extension of this frame cross tie is also used to support the ends of the longitudinal casting which extends outside the wheels between it and the guide yoke and carries the reverse shaft and link bearings.

Side pieces lipping over the saddle and secured to the frame casting prevent the frames from falling away from the boiler in case of derailment.

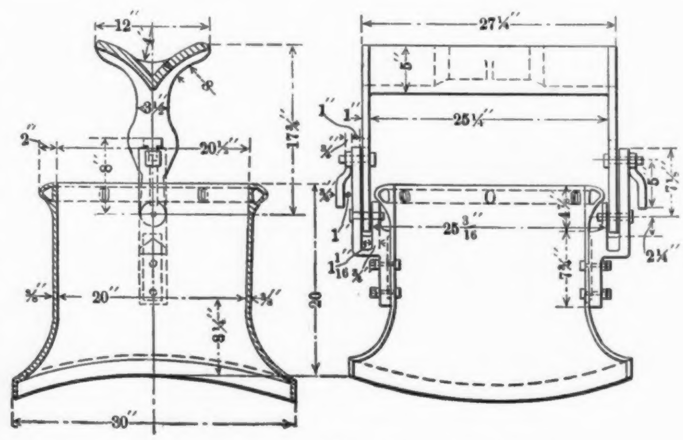
Reversing Gear.—As mentioned above, the two sets of valve gear are opposed for balancing each other, but even under these conditions the weight is too great to be handled conveniently by the ordinary reversing lever and the Raggonet power reversing gear, which was fully described on page 260 of the July, 1908, issue, is used. This gear is very similar to that used in marine practice and is operated by compressed air. It is self-locking and has proven to be most satisfactory in practice. From the reverse shaft on the rear engine the connection to the front reverse shaft is carried forward in the center of the locomotive, just above the frames, each shaft having a downwardly extending arm in the center. In order to prevent any derangement of the front valve adjustment when the locomotive is on a curve, a universal joint and bearing is provided in the reach rod where it passes through the high pressure saddle. This, as can be seen in the illustration, will permit free movement in both directions without any change in the length of the rod, and hence without movement to the front reversing shaft, when the forward group of wheels is swung out of line.

The stack is provided with a smoke deflector, arranged as the accompanying illustration shows. This is provided for use in tunnels in order to prevent the smoke from the stack mushrooming against the top of the tunnel and immediately coming down, thus cutting off the engineer's view. This deflector throws the smoke horizontally both ways and it is found that it will cling to the top of the tunnel and give the engineer a comparatively clear sight ahead.

ADVANTAGES OF BRIQUETTED OVER RAW COAL.

In general the following advantages may be claimed for briquets made from bituminous coal over the same coal not briquetted:

Comparative absence of smoke.
Uniformity of size and quality.
Less loss of fuel in ash.
Increased furnace and boiler efficiency.
Reduced consumption of fuel per ton-mile.
More fuel can be burned per square foot of heating surface, hence greater capacity.



SMOKESTACK AND DEFLECTOR—S. P. MALLET.

Less slack in handling fuel.
Less clinker and cinders.
Longer life of grates.
Fires can be kept up for longer periods without cleaning.
Less cleaning of tubes.
Less labor in firing, hence greater efficiency of fireman.
Less draft needed.
More uniform steam pressure.
Steam pressure can be increased more rapidly.
No liability to spontaneous combustion.
Availability for storage without deterioration.—*C. T. Malcolmson before The International Ry. Fuel Assn.*

AIR OPERATED DROP DOORS ON SUMMERS' ORE CARS

As stated in the August issue, page 338, in connection with the account of the results that the Summers' ore cars are giving in service on the Duluth & Iron Range Railroad, a part of these cars have been equipped with a device for operating the drop doors by air. Although the Summers' cars, when the doors are operated by hand, may be unloaded in very much less time and with fewer laborers than required for either the special ore cars or the ordinary type hopper car, the cars with the Summers' air operated doors may be unloaded in a fraction of the time required for those operated by hand.

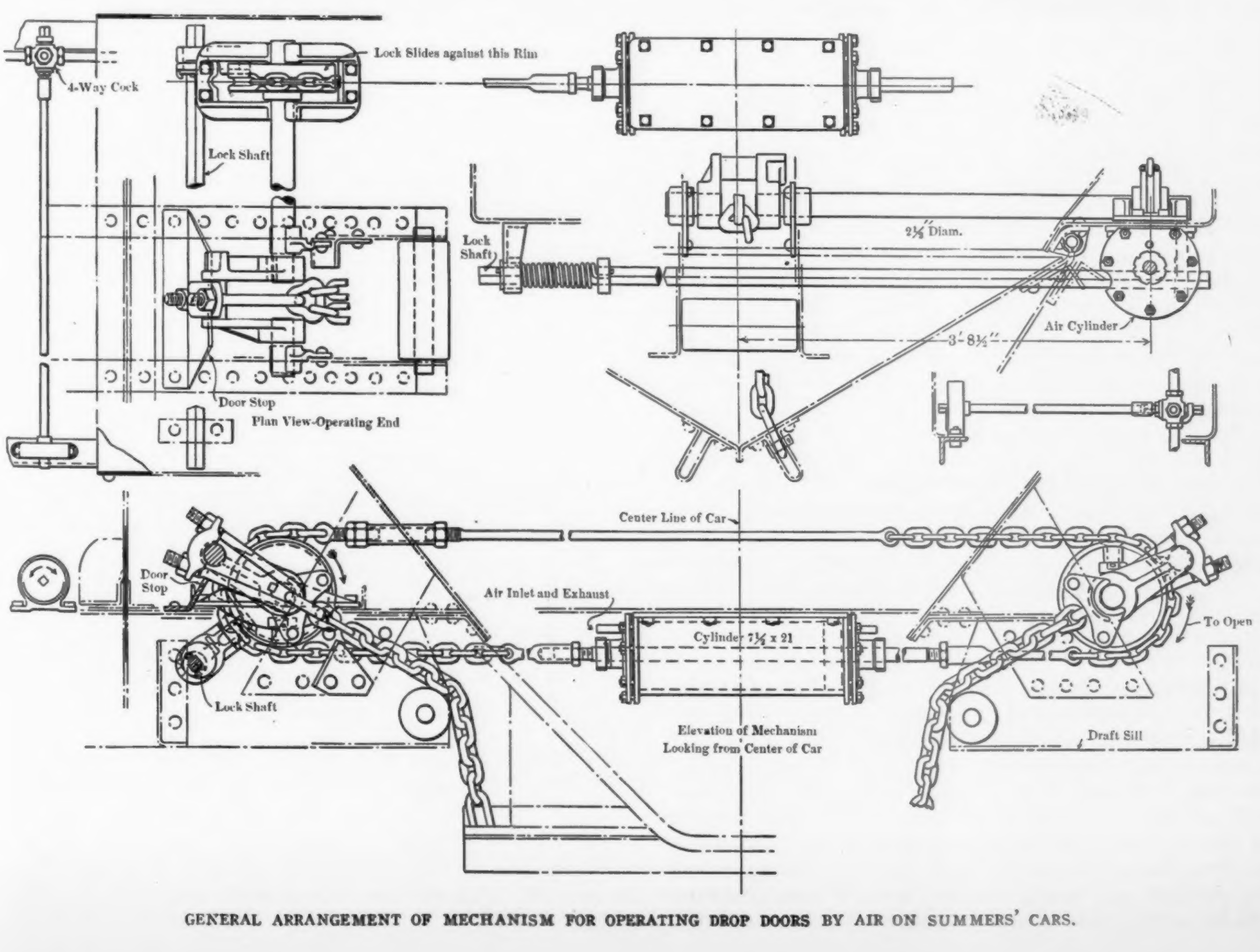
The Duluth, Missabe & Northern Railway Company recently borrowed a couple of Summers' cars from the lot of 800 furnished by the Summers Steel Car Company to the Duluth & Iron Range Railroad, in order to make some comparative tests of unloading a number of special ore cars. The results of these tests are shown in the following table. It will be seen that the Summers' cars required only one man for unloading as against four and eight on the other cars; also that the total time required for unloading was very much less, especially on the car equipped with the air operated doors, the performance of which was remarkable.

Number of Cars	Light Weight	Weight of Ore in Long Tons	Per Cent. Pay Load	Sq. Ft. Door Opening	Time Commence to Open Doors	Time Doors Closed	Total Time Consumed Min. Sec.	Number Men Working on Car		
								Winding Doors	Punching Ore	Cleaners and Bumpers
D. M. & N., 11,591	32,400	40-1,400	73.74	23.33	4: 18-50	4: 21-41	2-51	2	4	2
D. M. & N., 8,930	32,200	38-2,140	73.54	20.85	4: 16-15	4: 18-29	2-14	2	4	2
Summers, Hand Operated 9,985	31,000	38- 880	73.50	44.90	4: 10-51	4: 12-15	1-24	1	0	0
Summers, Air Operated, 10,384	31,300	38- 780	73.29	44.90	4: 03-00	4: 03-14	0-14	1	0	0
Clark, 170	32,000	37-1,920	72.60	35.50	4: 06-42	4: 10-00	3-18	2	0	2
C. & N. W., 27,345	31,000	39- 440	73.90	43.00	4: 12-37	4: 15-51	3-14	2	4	2

NOTE.—D. M. & N., 11,591, had original doors re-arranged at Proctor. D. M. & N., 8,930, had standard style of doors used on steel cars. Weather: Fair.

The general arrangement of the mechanism for operating the doors by air is shown on the drawing. The cylinder with the extended piston rod is bolted underneath the car at the side. The piston rod and the chain form a continuous belt over the sheaves at the outer end of the shafts which operate the cranks connected to the door chains. When the cranks are on the dead center at the upper end of the stroke, as shown, the doors are in a closed position. When in this position a lock, which slides against the rim of the sheave at the outer end of the operating shaft, engages a notch, thus locking the door closed. This lock is automatically operated by a spiral spring at the other end of the lock shaft.

To open the doors the lock shaft is given a quarter of a turn, thus unlocking the sheave; the four-way valve which controls the air supply to the cylinder is then operated, causing the cranks to move in the direction indicated by the arrows on the drawing. Both the four-way valve and the lock-shaft may be operated from either side of the car. The valve is returned to its central or closed position by a spring in a case at the opposite end of the shaft, as shown. When the doors are wide open the cranks to which the door chains are attached are on the dead centers in the lower position. When the doors are closed there is a stop for the crank at the left just beyond the dead center, as shown. This device, which is patented, is simple and effective and should not easily get out of order.

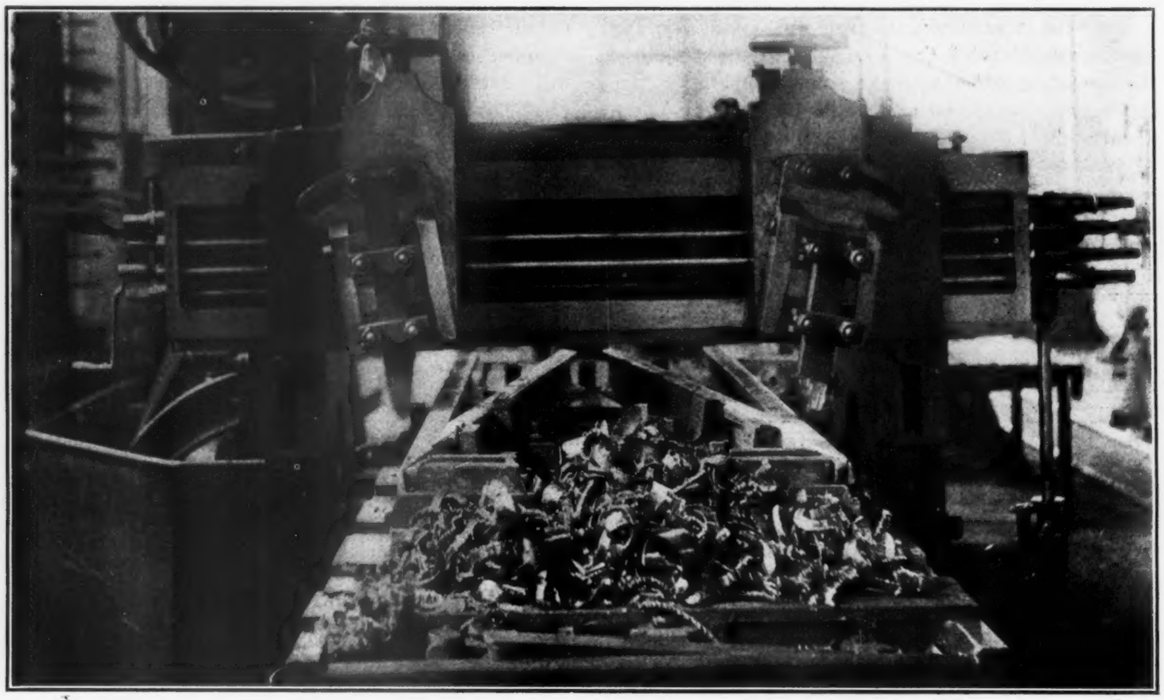


GENERAL ARRANGEMENT OF MECHANISM FOR OPERATING DROP DOORS BY AIR ON SUMMERS' CARS.

GOOD PLANER RECORDS.

Splendid work is being done at the Toronto shops of the Grand Trunk Railway on some frog and switch planers, built by The John Bertram & Sons Co., Ltd., Dundas, Ontario. These planers are identical with the Niles-Bement-Pond planers, specially designed for this class of work.

An important feature in connection with the work on these machines is the fixtures for setting and holding the rails rigidly. These were designed by the foreman of the shop, Mr. Garden. The frog planer has a table 16 ft. long and in nine hours finished 32 frog points, removing 576 lbs. of metal. A view of part of this machine is shown in the illustration. The switch planer, with a table 23 ft. long, finished six pairs of 100-lb. rails in ten hours, removing 1,140 lbs. of material.



FROG PLANER AT THE TORONTO SHOPS—GRAND TRUNK RAILWAY.

It should be understood that these are not "break-neck" records with men clustered around the machine and every one keyed to the highest pitch, but are tests of what the machine is capable of doing under ordinary service conditions. Both of the machines are belt driven, but are arranged so that they may be changed to a motor drive in the future. The following data gives the time required for some of the different operations on 80-lb. rails, the men working on piece work. This is the time required for the average performance and is quite close to what was accomplished in the above mentioned tests. Cutting the side of the head on one rail required 15 strokes varying in length from short ones up to about 8 ft. The other rail was considerably harder and took 13 additional short strokes, the total time required being 12 minutes. Twelve strokes were required for planing the top of the rail, requiring seven minutes. Cutting off the flange, running back 11 or 12 ft., and cutting down to the web at the point required seven minutes.

"PENNSYLVANIA SPECIAL."—The Pennsylvania Railroad's eighteen-hour train between New York and Chicago has just completed a continuous record of four years' service. From June 12, 1905, when the train was started, to June 12, 1909, a total of 2,922 trips were made—1,461 in each direction—and upon 2,483, or 85 per cent. of these trips, the train was on time or within five minutes of its schedule at destination. The actual running time from Jersey City to Chicago is 17 hours and 41 minutes. The scheduled time is 57.2 miles per hour, or 1,061 minutes to cover 912 miles.

THE SLIPPING POINT OF ROLLED BOILER TUBE JOINTS.*

When a boiler tube has started from its original seat the fit may be no longer continuous at all points and a leak may result, although the ultimate holding power of the tube may not be impaired. A small movement of the tube under stress is then the preliminary to a possible leak and it becomes of interest to know at what stress this slipping begins. A knowledge of the slipping point of a tube in its relation to the ultimate holding power is somewhat analogous to a knowledge of the elastic limit of materials in relation to their ultimate strength, in that working stresses should be kept within the smaller values.

The analogy is further warranted by the appearance of the load-slip diagram from such a joint, which has a general resemblance to stress-deformation diagrams of tension tests of steel.

Figure 1 is a typical diagram of the action of a 3-in. twelve-gage, Shelby cold drawn tube expanded into a straight machined hole in a 1-in. plate, the tube end projecting ½ in. and not flared

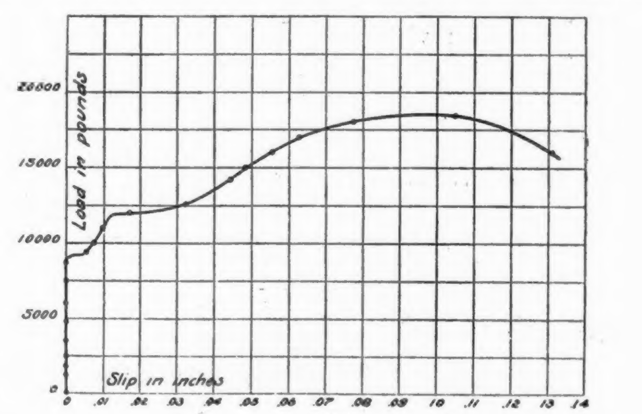


FIG. I.

The figures to the left give the total force applied to pull the tube from its seat; the figures below, the total slip or movement of the tube through the hole. The curve shows the relation between the load applied and the corresponding slip

The tube in this joint began to move at 9,000 lbs. and shows a

* Abstract of a paper by Prof. O. P. Hood and Prof. G. L. Christensen presented at the December meeting of the American Society of Mechanical Engineers.

decided slip at 12,000 lbs, reaching an ultimate holding strength of 18,000 lbs.

There is a considerable probability that this joint would leak after the tube had slipped and be condemned because of its leakiness. This slip occurs at 50 per cent. of the ultimate holding strength of the joint and at 29 per cent. of the elastic limit of the material in the tube.

There is then a considerable field for improvement in which to raise the slipping point to a higher per cent. of the ultimate stength of the joint or of the elastic limit of the tube. The usual design seems sufficient for most cases, but where high pressures are used or where the stresses due to temperature variations are large, a joint with a higher initial slipping point seems necessary.

In many boiler designs a certain few of the tubes seem to be more highly stressed in service than others and for such designs a joint of high initial slip would be an advantage. As an illustration, a 3-in. tube under 225 lb. boiler pressure would be urged from its seat by a force of about 1,600 lbs. due to pressure alone. In many tests the initial slip comes at about 6,000 lbs. This gives a factor of safety of 3.75 within the slipping point to take care of the unknown temperature stresses. If the design calls on the tube to act as a stay and support the pressure of but 16 sq. in. this factor of safety within the slipping point is reduced to about 1.7.

In attempting to strengthen the usual joint it might appear that harder rolling of the tube would raise this slipping point, but experiment does not show this. Harder rolling within certain limits will raise the ultimate holding power but has little effect on the initial slip.

The recommendation to flare the projecting end of the tube has high authority and is of value, but while this raises the ultimate holding power it does not alter the original slipping point. It seems evident that this flared portion would have to be moved into the hole before its metal could come into play and this initial movement might be the cause of leakage.

If the holes into which the tubes are rolled are tapered 1-10 in. in diameter per inch in thickness of the plate the first slipping point is hardly affected, but the joint is more rigid after a slip of 1-100 in. and the ultimate strength is increased. In Figure 2 curves 12 and 35 represent the results from straight holes; while curves 6 and 38 are typical of those having tapered holes. These curves show the slipping points as agreeing in general, but those from tapered holes rise more rapidly and are thus more rigid.

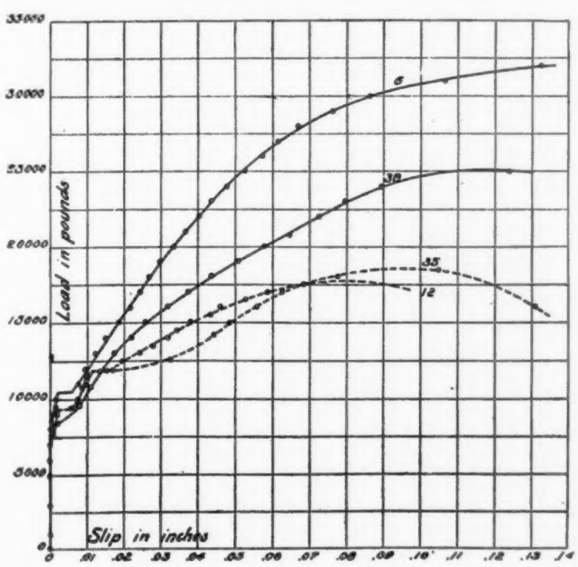


FIG. 2.

During the progress of these experiments a form seemed wanted, to put the rolled metal under an initial stress in the direction of the axis of the tube, thus reinforcing the frictional resistance to the first slip. A tapered hole in the sheet was therefore given a reverse taper also, so that its smallest diameter was ⅛ in. from the tube side of the sheet.

This amounted to a slight chamfering of the inner side of the tube sheet. Rolling the tube against the two tapers would develop such stresses along the tube as should help to resist movement. In Figure 4 numbers 36, 44, 26, 25, 38 and 37 had double taper. Compared with the straight holes the general effect was to lower the slipping point somewhat but increase the rigidity.

A study of the several tests made shows that in the usual ma-

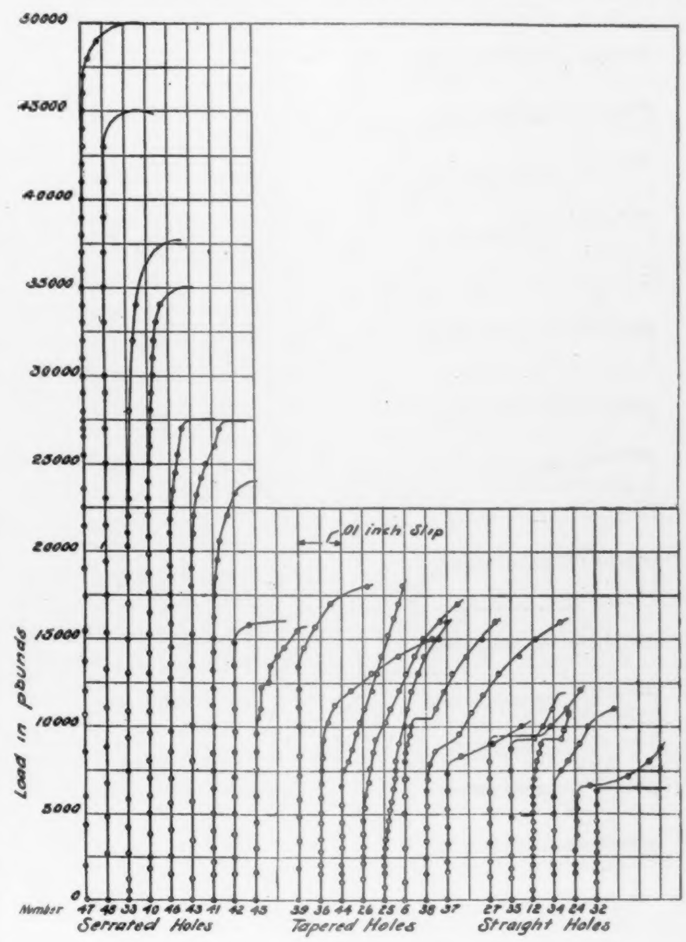


FIG. 4.

chined joint the resistance to the first slipping comes from friction only. The friction is dependent on the normal pressure of the expanded tube against the sheet and this will be a maximum when the rolled metal of the tube is stressed to its elastic limit. The rolling of the metal elevates the elastic limit, but it takes a small amount of rolling to reach this maximum value. Further rolling reduces the thickness of the metal in play as fast as the elastic limit is exalted.

Assuming the elastic limit of the rolled metal at from 30,000 to 40,000 lbs., the observed slipping point shows that the coefficient of friction must have been 35 to 26 per cent. The total friction per square inch of tube bearing area seems to be about 750 lbs. in tube plates ⅝ and 1 inch thick. It was observed that in straight and tapered holes wherever a high final strength was attained the metal of the tube was in some way abraded. Sometimes the sharp edge of the tube plate would shear a small ring from the metal of the tube and in other cases patches of the metal had apparently seized and sheared. Computing the probable frictional resistance of these joints and adding the resistance of the sheared area shown on the tube gave a result agreeing closely with the observed ultimate strength of the joint as tested.

Most of these joints also showed a relatively high slipping point, suggesting the necessity of providing shearing resistance in addition to frictional resistance in order to obtain a high resistance to initial slip. Several forms were therefore made which provided square shoulders in the tube sheet for the tube to be rolled against, with the object of making these several edges abrade the tube when it started to move This serrating of the holes amounts to but little more than a "rough cut" in machining

Form of Joint	Taper per inch	Test No.	Load in pounds at point of: Initial Slip	Slip = 1/100 inch	Ultimate Load	Slip in inches at point of Ult. Load
Tube Sheet 1" thick						
Straight and Tapered	.06	1	7800	8000	8400	.02
		2	7800	9500	11400	.05
		7			17200	.12
Flared, Straight, and Tapered	.06	4	6000	10300	11500	.07
Flared, Chamfered, Straight, and Tapered	.06	5	4000	7600	15000	.06
Tapered and Straight	.06	3	7000	7800	26000	.112
Double Taper	.10	8	15000	17500	30000	.04
		9	14500	15500	21000	
Tube Sheet 5/8" thick						
Straight		11.	5000	6100	6400	.03
		15	4500	7000	9500	.04
		16	3700	5900	17000	.088
Punched		18	8000	14700	17000	.044
Double Taper	.10	23	6500	12000	16000	.04
Tube Sheet 1/2" thick						
Straight		10	2000	5600	7400	.03
		14	2000	6800	9500	.035
		17	3000	6000	20000	.06
Punched		19	10000	17200	17500	.022
		20	3500	17000	23000	.036
Double Taper	.10	22	7000	15000	27000	.048
Tube Sheet 3/8" thick						
Straight		13	1300	7000	18000	.045
Punched		21	8000	15200	16500	.027

Form of Joint	Serrations: Number per inch	Serrations: Depth in inches	Test No	Load in pounds at point of: Initial Slip	Slip = 1/100 inch	Ultimate Load	Slip in inches at point of Ult. Load
Tube Sheet 1" thick							
Straight Machined Hole			12	7000	11500	17700	.085
			24	6000	7000	20000	.12
			27	9000	9500	21000	.10
			32	6400	6000	6400	–
			34	6800	10500	11500	.035
			35	8800	11200	18400	.105
Average				7333	9283	15833	.089
Double Taper (Taper 1/16" in diam. per inch)			25	3500	14000	23000	.08
			26	5500	12800	19700	.047
			36	8200	12600	16500	.042
			37	7500	8900	23000	.178
			38	7000	10300	25000	.124
			44	7500	14400	33000	.069
Single Taper			6	8500	12200	32000	.133
			39	13500	17500	22600	.354
Average				7650	12837	24350	.128
Serrated	10	005	45	10000	15500	15800	.015
	10	010	46	22000	27500	27500	.008
	10	015	47	45000	50000	50000	.012
	10	020	48	43000	45000	45000	.003
Serrated	10	015	33	23000	37500	37700	.012
	10	015	40	25000	35000	35000	.01
	10	007	41	16500	23800	24200	.015
	16	007	43	21000	27200	27200	.006
	64	002	42	15000	16000	16000	.010

FIG. 3.

Figure 3 gives the significant results obtained in several series of tests and Figure 4 shows them graphically up to the slipping point.

To discover how much roughening was desirable a series of tests were made with straight holes, in which a shallow square thread was cut with a pitch of ten threads to the inch and from 0.005 to 0.020 in. deep. The tube ends were not flared. No. 45, 46, 47, 48 show the results from these serrated holes, in which it appears that the slipping point may be very greatly elevated by this means.

With serrations 0.005 in. deep the surface is barely roughened and the slipping occurs at 10,000 lbs. This is increased successively to 16,000, 22,000 and 45,000 lbs. by increasing the depth of the grooves to 0.007, 0.010, and 0.015 in., respectively. The elastic limit of the tube is reached in tension at about 34,000 lbs. and this load was exceeded by a number of the tubes before there was any slip.

In test 41 the hole in the tube sheet was serrated by rolling with an ordinary flue expander, the rolls of which were grooved 0.007 deep and 10 grooves to the inch. This method of serrating is easy and can be recommended where tubes are giving trouble from slipping and are required to carry an unusual load.

This tube has the slipping point raised to three or four times the usual value. It appears that with serrations about 0.015 inches deep giving an abutting area of about 1.4 sq. in. in a seat one inch wide that the maximum strength is reached as shown in tube 47.

SUMMARY.

a The slipping point of a 3-in. twelve-gage Shelby cold drawn tube rolled into a straight smooth machined hole in a 1-in. sheet occurs with a pull of about 7,000 lbs.

b Various degrees of rolling do not greatly affect the point of initial slip.

c The frictional resistance of such tubes is about 750 lbs. per square inch of tube-bearing area in sheets 5/8 inch and 1 inch thick.

d For a higher resistance to initial slip other resistance than friction must be depended upon

e Serrating the tube seat in a straight machined hole by rolling or cutting square edged grooves about 0.01 in. deep and ten pitch will raise the slipping point to three or four times that in a smooth hole.

f It is possible to make a rolled joint that will offer a resistance beyond the elastic limit of the tube and remain tight.

Central Railway Club.—The next regular meeting will be held at Buffalo on Friday, September 10. The annual fall outing will be held at this time, the boat leaving the foot of Main street at 10 A. M., the trip being down the north channel of the Niagara River, around Grand Island and thence to Electric Beach on the American side, where a fish and chicken dinner will be served. There will be music and refreshments on board. Tickets for the dinner will be 50 cents for members and $1.00 for guests. The evening meeting will be held at the Hotel Iroquois at eight o'clock, the paper being an illustrated lecture on "The Safe Transportation of Explosives and Other Dangerous Articles" by Col. B. W. Dunn.

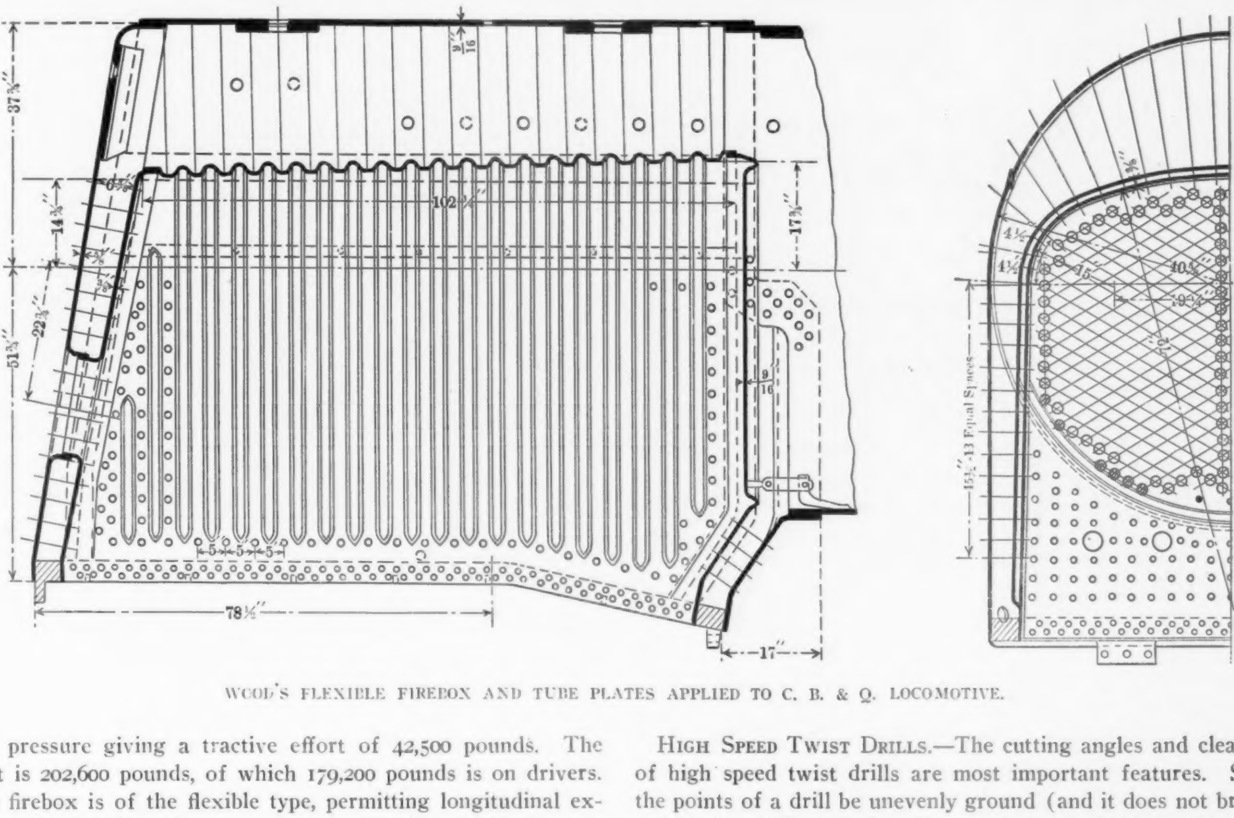
During 1908 the New York street cars killed 444 persons and injured 35,060 others.

WOOD'S FIREBOX AND TUBE PLATES FOR HEAVY CONSOLIDATION LOCOMOTIVE.

CHICAGO, BURLINGTON & QUINCY RAILROAD.

The accompanying illustrations show the details of the firebox and tube plates which are being applied to the boiler of a heavy consolidation locomotive on the Chicago, Burlington and Quincy Railroad by the William H. Wood Locomotive Firebox and Tube Plate Company, of Media, Pa.

This locomotive is known as Class D4, and was fully described on page 48 of the February, 1903, issue of this journal. It has 22x28-inch cylinders, 57-inch drivers, and 210 pounds steam pressure giving a tractive effort of 42,500 pounds. The weight is 202,600 pounds, of which 179,200 pounds is on drivers.

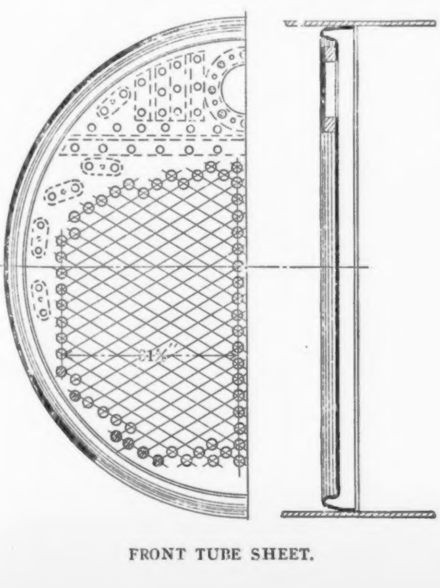


WOOD'S FLEXIBLE FIREBOX AND TUBE PLATES APPLIED TO C. B. & Q. LOCOMOTIVE.

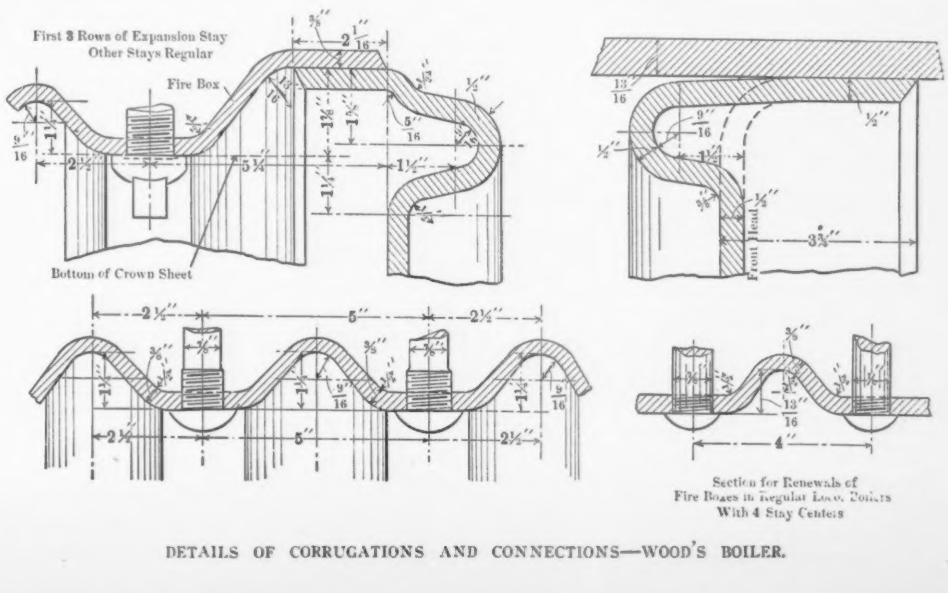
The firebox is of the flexible type, permitting longitudinal expansion of the side and crown sheets to be taken up by the corrugations between the staybolts, in addition to flexible tube plates, front and back, which take care of the expansion of the tubes as well as the firebox plates, and prevent the concentrating of the expansion stresses at any one point, which, no doubt, in the ordinary boiler, is responsible for much of the trouble with leaky tubes and stays and cracked side sheets.

RAILROAD Y. M. C. A.—We believe that the Railroad Y. M. C. A. has been and is doing a very necessary work for the social, mental and physical improvement of our employees, and because of this opinion the Grand Trunk Railway Company has contributed to December 31, 1907, the sum of $72,758 toward the construction, enlargement and improvement of the fourteen associations located at division points on our system of railways. The company is also contributing a large sum per annum towards the expenses of operating and maintaining these associations, with the belief that the indirect benefit in a financial way is in excess of the amount expended, because of the better condition of our men, both mentally and physically, to perform their duties in connection with the operation of our trains, the maintenance of our road and the service generally.—*Chas. M. Hays, Second Vice-President and General Manager.*

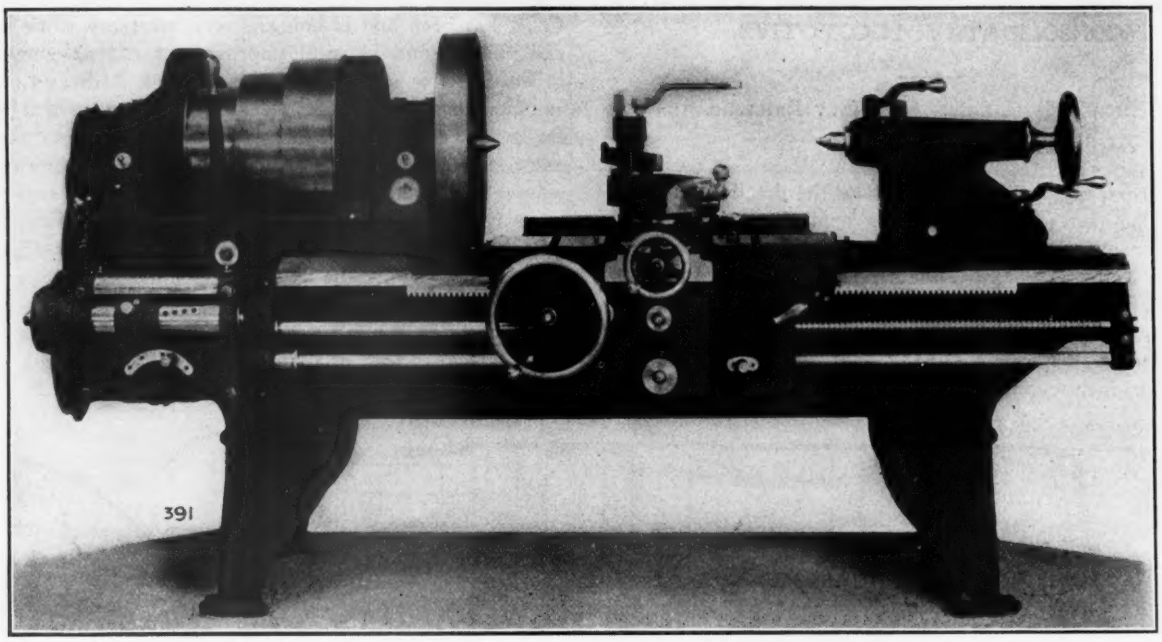
HIGH SPEED TWIST DRILLS.—The cutting angles and clearances of high speed twist drills are most important features. Should the points of a drill be unevenly ground (and it does not break in work), it will be found to bore an eccentric hole, one lip having done all the duty. The lips must be of equal length and at the same angle. The angle of the cutting point should be 59 degrees for steel, but for cast iron it may be much more pointed. At Clyde Works an angle of 45 degrees has been adopted for experimental work on cast iron.—*Fred M. Osborn before the Leeds Assn. of Engineers.*



FRONT TUBE SHEET.



DETAILS OF CORRUGATIONS AND CONNECTIONS—WOOD'S BOILER.



TWENTY-INCH HEAVY DUTY ENGINE LATHE.

HEAVY DUTY ENGINE LATHES.

THE R. K. LEBLOND MACHINE TOOL CO.*

A given number of cubic inches of metal removed per minute is the basis of a design of a new line of heavy duty engine lathes, which have recently been perfected by the R. K. LeBlond Machine Tool Co. The lathe shown in the illustration is the 20-inch size, and is capable of taking a cut ¼-inch deep with $^1/_6$-inch feed at the rate of 65 feet per minute on a piece of 50-point spindle steel, which gives it a capacity of removing 32 cubic inches of this very tough material per minute. In addition to the 20-inch size the same machine is also made in 16, 24 and 30-inch sizes.

Although there are a large number of new ideas presented in the construction of this lathe there is nothing which might be called a radical departure from previous practice, and it has been the aim of the manufacturers to produce a tool without complications, easy to manipulate, of great rigidity and capable of transmitting a large amount of power.

Considering some of the details separately, the head stock is of the drop-braced pattern, of great rigidity and is securely fastened to the bed with bolts of large diameter. A three-step cone used in connection with friction back gears and a two-speed countershaft, which gives 18 changes of spindle speed covering a carefully selcted range.

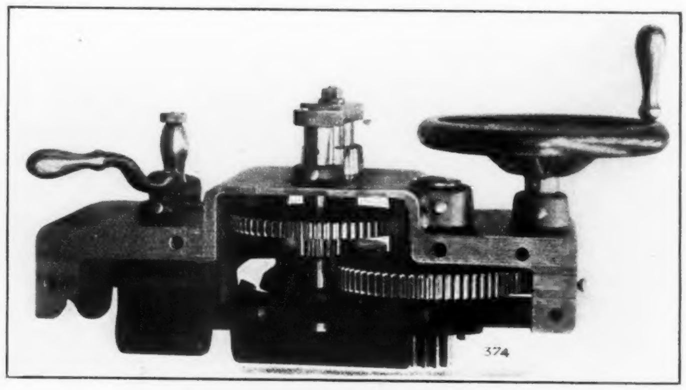
The hollow spindle, which is made of high carbon hammered steel, has hardened and ground front and rear journals. These journals are carried in special cast-iron boxes, carefully scraped to a bearing. This type of bearing does not require intricate oiling devices with continual attention from the operator, but the lubrication is, nevertheless, well taken care of. The bearing pedestals are cored out to form large oil chambers, filled from the front of the lathe, from which the oil is fed to the bearings by means of felt pads. This construction precludes all possibility of grit entering the bearing and reduces the attention required to a weekly filling of the oil receptacles.

The tail stock slides on a V of the usual proportions on the rear way, and on a flat surface in front. The carriage travels on a flat surface on the back and is held down at that point by a flat gib. The front of the carriage slides on a guide, however, of different shape than that usually found on engine lathes. This guide, or V, as is shown in one of the illustrations, is machined at an angle of 15 degrees on the front side and 70 degrees back angle. It is well known that the force exerted downward on the carriage of an engine lathe is many times the outward pressure, and in designing this bed the wearing surfaces have been proportioned accordingly.

* Cincinnati, Ohio.

The bed, in addition to having an unusually deep section, is reinforced and braced by a transverse rib of I-beam section, directly under the front bearing; this extends up to the extreme top of the bed. In addition the metal around the holding-down bolts has been reinforced to about three times the thickness usually found at this point.

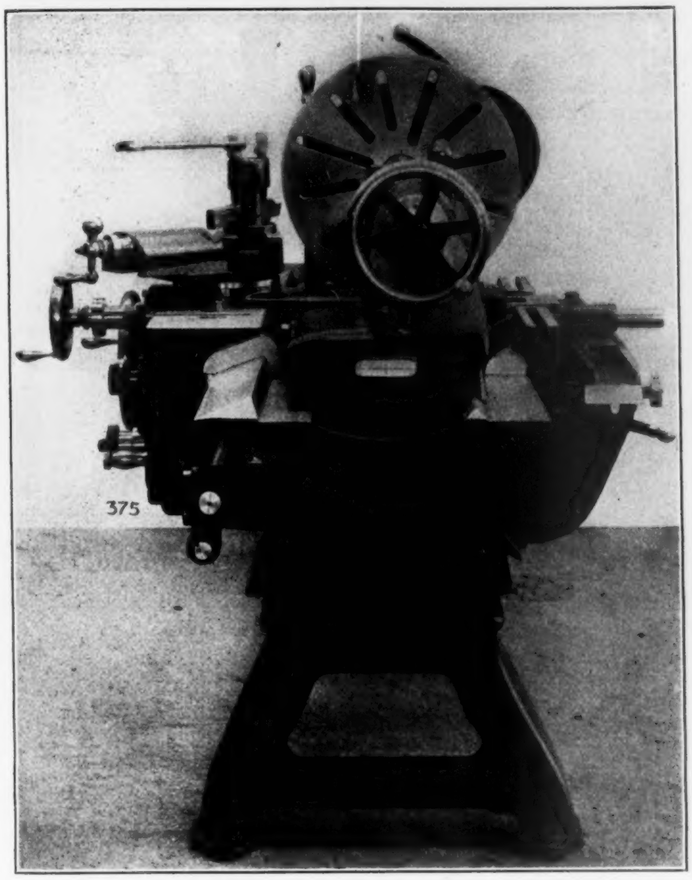
The carriage is extremely rigid and is carefully scraped to a bearing for its entire length on the bed. It is held in perfect alignment by taper gibs on either end bearing on a scraped surface at the front of the bed, which, together with the 70-degree back angle on the V, overcomes any tendency to climb the ways when engaged on heavy work. These gibs are tongued in position on the carriage and they, together with the form of V, form a construction that automatically compensates for wear and makes it unnecessary to give any attention to the adjustment of the gibs. Carefully designed wipers are provided, fitted with felt pads, which in addition to wiping off any grit also automatically oil the sliding surfaces.



TOP VIEW OF APRON.

The spindle, as will be seen, is set back some distance from the center of the shears, which not only gives an increased swing over the carriage, but at the same time permits the machine to be used at full swing without the tool overhanging the bed. This gives great rigidity on work of large diameters.

The apron is a one-piece box section casting, with all gears and studs supported at either end. The top view clearly shows



VIEW SHOWING OFFSET OF SPINDLE AND SHAPE OF GUIDES.

the wide bearing by which it is attached to the carriage. The tongue is accurately fitted to the carriage and the apron is rigidly held in position by four bolts of large diameter. This single box section form of apron does away with the necessity of an auxiliary support at the lower end and overcomes the difficulty of uneven wear between such lower slides and the V on the top of the bed.

The longitudinal and cross feeds are operated by a single friction, which, in addition to being of large diameter, is so placed in regard to the gearing, that it has but a slight duty to perform. The feeds are engaged in the apron by an in and out movement of the knob shown on the front. This moving member has a central position, which disconnects all the gearing when a lathe is used for screw cutting. The apron is further provided with a device which makes it impossible to engage the feed rod and lead screw at the same time.

The tail stock is of massive design with bearing of ample length on the bed and rigidly clamped by two clamping bolts of large diameter, centrally located between the shears. The tail spindle barrel is designed in such manner to give the maximum length of bearing and long travel. Suitable screws are provided for setting over for taper work, the base being graduated so that this setting can be easily accomplished.

The quick change gear box supplied with these lathes is said to be the only device of this kind on the market in which the entire mechanism is contained in one unit. Nine changes of speed are obtained by means of a cone of gears and the tumbler. It will be seen that this tumbler gear is supported on a large cylindrical bearing and is securely locked in position by the plunger in the change handle. This construction has been used on the lathes manufactured by this company for some time. The nine changes mentioned above are quadrupled by the addition of the sliding gear transmission, which is well illustrated in one of the cuts. This construction permits the use of a direct reading index plate, from which the operator can read the position of the levers instantly. The 36 changes of threads, ranging from 2 to 30, are all made while the lathe is running under the heaviest cut. The gears in this box, as well as all other feed gears, are made from drop-forged steel. The feed rod is driven by the same mechanism, suitable gears connecting it with the lead screw, giving a feed range from 8 to 120.

The feed box is connected to the spindle by means of gears, the intermediate one of which is mounted on a quadrant, which permits the use of special or compound gearing at this point to cut special threads or metric threads with the U. S. S. standard lead screw or vice versa.

THE TENDENCY OF LOCOMOTIVE BOILER DESIGN IN EUROPE.

The conclusions of subject VI, sections A and C, on the question of improvements in locomotive boilers covering Belgium, Spain, France, Italy and Portugal, and printed in the bulletin of the International Railway Congress, are as follows:

Section A—

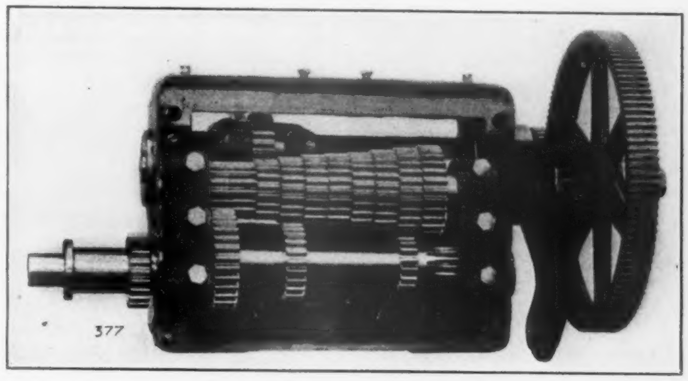
The actual tendencies as regard the construction of fire-tube boilers are: The retention of copper fire-boxes; the use of stays in the fire-boxes; the introduction of rocking grates; the adoption of steel tubes, except where the water is bad; a fall in the favor with which ribbed tubes have been regarded during the last ten years or so; the application of means for reducing leakage at the tubes and damage to the tube-plates without any definitely successful results having yet been obtained in this direction.

Section C—

The principal damage to boilers due to: Cracks in the fire-box tube-plate, in the bends and in between the tubes; the wear of the lower part of the fire-box plates around the heads of the stays; cracks and grooves in the front and back plates of the fire-box and in the tube-plate of the smoke-box; pitting and general surface corrosion in the lower part of the barrel and along the seams.

Water of bad quality accelerates the production of these defects.

Consequently, the purification of feed water of medium quality is to be recommended; it becomes indispensable when the water contains a large proportion of alkaline earth salts. But in order to prevent priming, the purified water should contain as little sodium salts as possible.

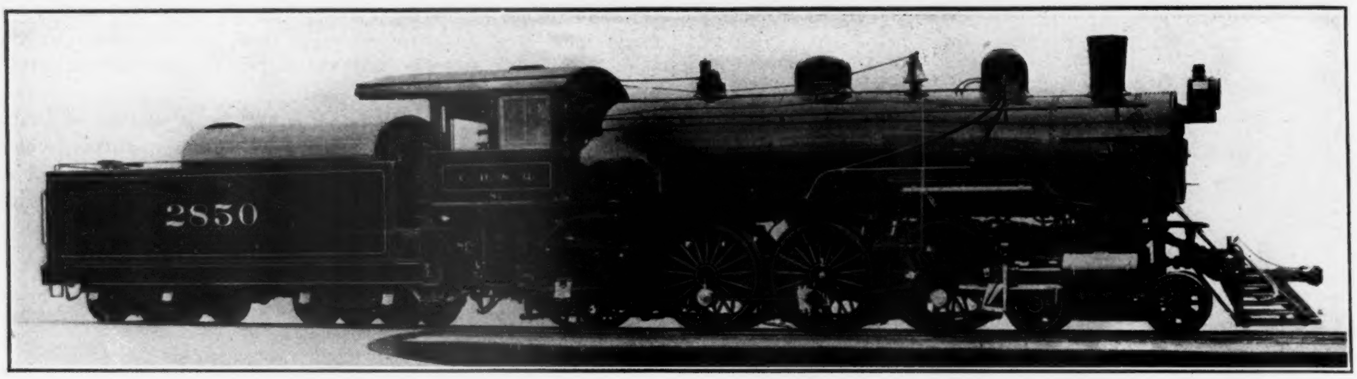


QUICK CHANGE GEAR BOX.

The use of disincrustants is also to be recommended, although they do not do away with the formation of scale and are only a palliative.

Washing out the boilers with hot water and blowing off under pressure help to keep the boilers in good condition.

ORGANIZATION.—Organization presupposes an organizer. Upon him, then, depends success. The call is for industrial leaders able to see broadly over the needs of a business, to subdivide and plan its work into departments, to understand men and study their personalities, to train them and to select the right man specialized and qualified for each place.—*Prof. H. Wade Hibbard before the St. Louis Railway Club.*



PACIFIC TYPE LOCOMOTIVE—CHICAGO, BURLINGTON AND QUINCY RAILROAD.

PACIFIC TYPE LOCOMOTIVE.

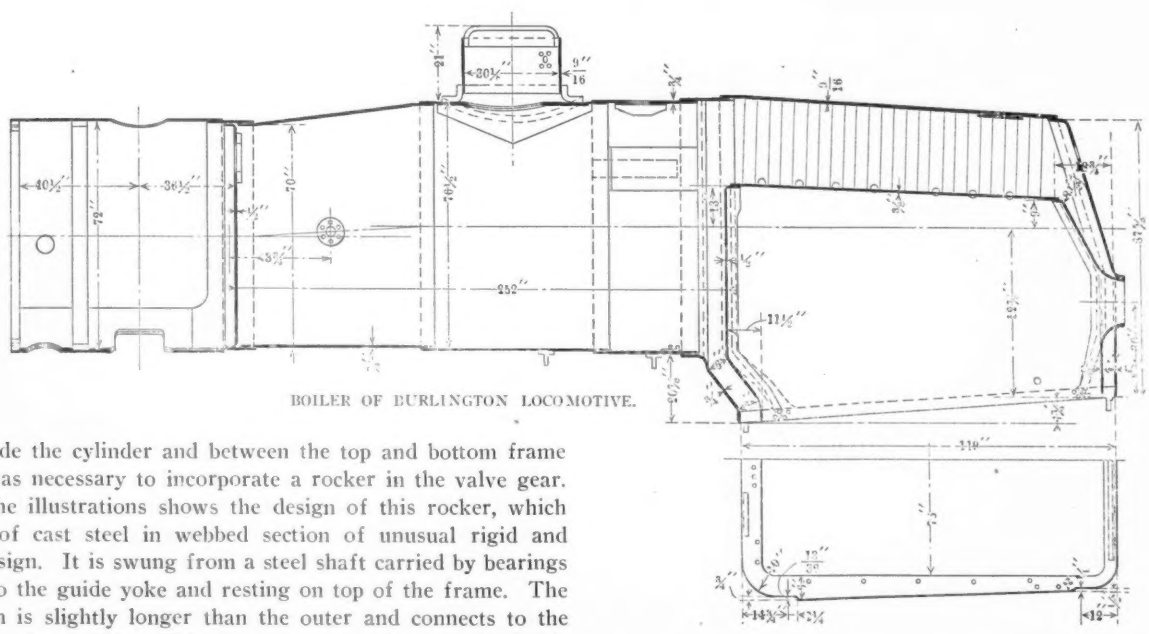
CHICAGO, BURLINGTON & QUINCY RAILROAD.

About three years ago the Chicago, Burlington & Quincy Railroad received thirty large Pacific type locomotives from the Baldwin Locomotive Works, which were illustrated and described on page 300 of the August, 1906, issue of this journal. These engines were built to specifications furnished by the railroad company and were a direct development from the Prairie type locomotive which has been in most successful use on that road for a number of years. The satisfactory performance of the new type is evidenced by the fact that the same builder has recently delivered an order of 25 more of practically the same weight and size. The chief changes made in the new design are in the use of the Walschaert valve gear in place of the Stephenson and in minor boiler alterations.

Since the same cylinder pattern was used as on the former order with Stephenson valve gear, which locates the 12 in. piston valve inside the cylinder and between the top and bottom frame rails, it was necessary to incorporate a rocker in the valve gear. One of the illustrations shows the design of this rocker, which is made of cast steel in webbed section of unusual rigid and strong design. It is swung from a steel shaft carried by bearings secured to the guide yoke and resting on top of the frame. The inner arm is slightly longer than the outer and connects to the valve stem by a link. This arrangement makes an admirable support for the weight of the gear and eliminates all possibility of the valve rod getting out of line because of the weight carried by it. The valve gear links are carried outside of the front driving wheel, being supported by longitudinal bearers connecting the guide yoke with the frame cross-tie between the first and second drivers, this being the same general arrangement that is commonly used on Pacific type locomotives.

The boiler, while very similar and of practically the same size as was used before, contains a novelty in the shape of a side water leg, which is 4 in. wide at the mud ring at the back end of the firebox and 6 in. wide at the forward end of the firebox, the mud ring being tapered, as is shown in the illustration. The number of flues has been reduced by ten to 293, the same diameter and length, however, being maintained. This reduces the total heating surface slightly, but not sufficient to affect the ratios materially. The grate area and size of firebox remains the same as before. The crown sheet has four rows of expansion links at the front end and the throat sheet completely encircles the barrel, being flanged out of a single plate. The safety valves and whistle are mounted on an auxiliary dome just ahead of the firebox. The smoke box has a short extension and is fitted with a spark hopper and low single exhaust nozzle.

The design of the frames is shown in the illustration. They are of cast steel, the front rail of the main frame extending to the front of the cylinders only. The cast steel bumper plate is braced by supplementary lower frames set at 23 in. centers, being secured below the cylinders and extending to the bumper beams. The rear frames, as has been the practice of this company from the beginning, are placed outside the trailer wheels and are connected to the main frames by a substantial steel casting. The trailer wheels are allowed a limited amount of side play and the boxes are braced transversely by tie rods. The load is transferred to the box through cast iron plates having inclined sliding surfaces.



BOILER OF BURLINGTON LOCOMOTIVE.

The general dimensions, weights and ratios of these locomotives are as follows:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Passenger
Fuel	Bit. Coal
Tractive effort	31,100 lbs.
Weight in working order	234,900 lbs.
Weight on drivers	160,150 lbs.
Weight on leading truck	37,400 lbs.
Weight on trailing truck	37,350 lbs.
Weight of engine and tender in working order	390,000 lbs.
Wheel base, driving	12 ft. 10 in.
Wheel base, total	32 ft. 9 in.

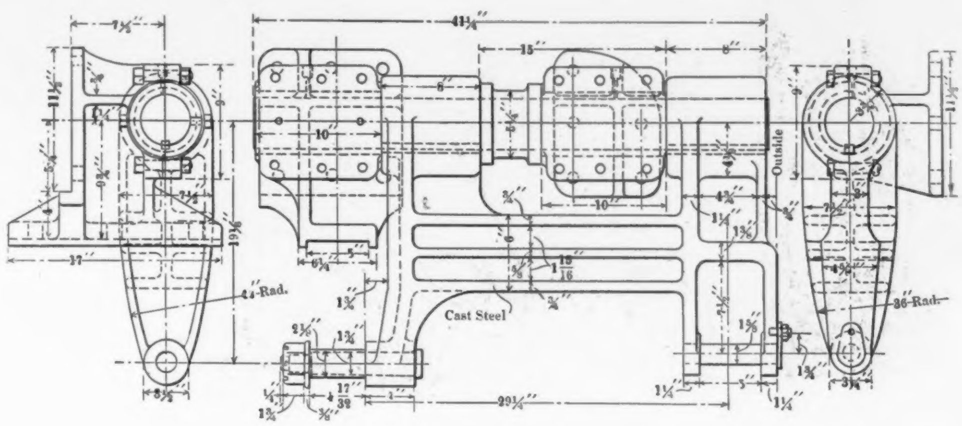
Wheel base, engine and tender	64 ft. 3¼ in.

RATIOS.

Weight on drivers ÷ tractive effort	5.17
Total weight ÷ tractive effort	7.55
Tractive effort × diam. drivers ÷ heating surface	605.00
Total heating surface ÷ grate area	69.20
Firebox heating surface ÷ total heating surface, per cent	5.10
Weight on drivers ÷ total heating surface	42.40
Total weight ÷ total heating surface	61.30
Volume both cylinders, cu. ft.	12.30
Total heating surface ÷ vol. cylinders	310.00
Grate area ÷ vol. cylinders	4.48

CYLINDERS.

Kind	Simple



ROCKER ARM AND SUPPORT—BURLINGTON LOCOMOTIVE.

Diameter and stroke	22 × 28 in.

VALVES.

Kind	Piston
Diameter	12 in.
Greatest travel	5¾ in.
Outside lap	1⅛ in.
Inside clearance	⅛ in.
Lead, constant	¼ in.

WHEELS.

Driving, diameter over tires	74 in.
Driving, thickness of tires	4 in.
Driving journals, diameter and length	10 × 12 in.
Engine truck wheels, diameter	37¼ in.
Engine truck, journals	6 × 12 in.
Trailing truck wheels, diameter	48¼ in.
Trailing truck, journals	8 × 12 in.

BOILER.

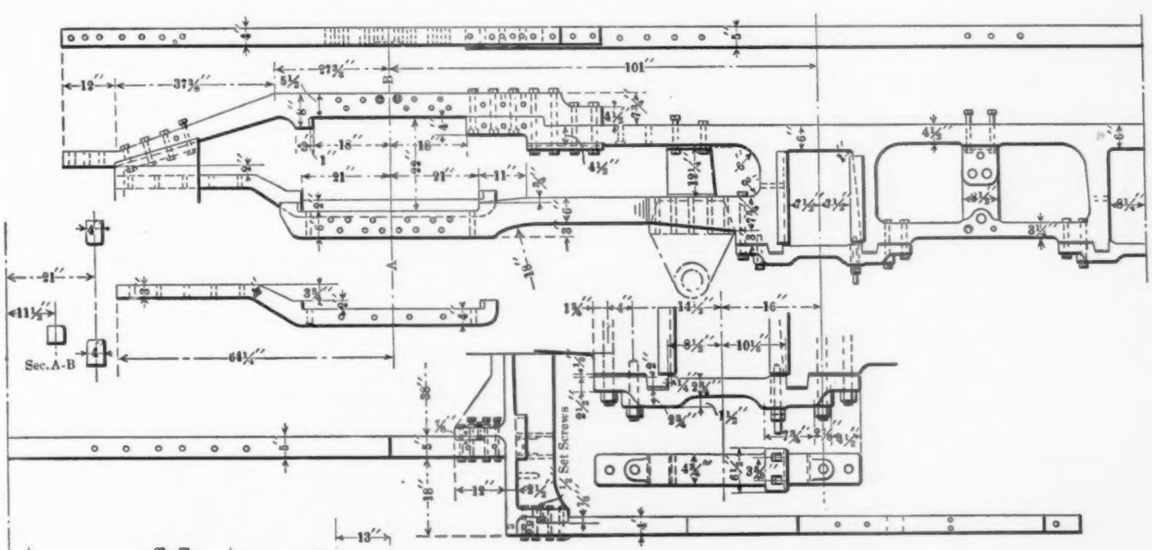
Style	W. T.
Working pressure	200 lbs.
Outside diameter of first ring	70 in.
Firebox, length and width	108⅛ × 72¼ in.
Firebox plates, thickness	⅜ & ½ in.
Firebox, water space	F.-6, S.-6 to 4, B.-4 in.
Tubes, number and outside diameter	293—2¼ in.
Tubes, length	21 ft.
Heating surface, tubes	3,610 sq. ft.
Heating surface, firebox	194 sq. ft.
Heating surface, total	3,804 sq. ft.
Grate area	55 sq. ft.
Smokestack, height above rail	182 in.
Center of boiler above rail	109⅞ in.

TENDER.

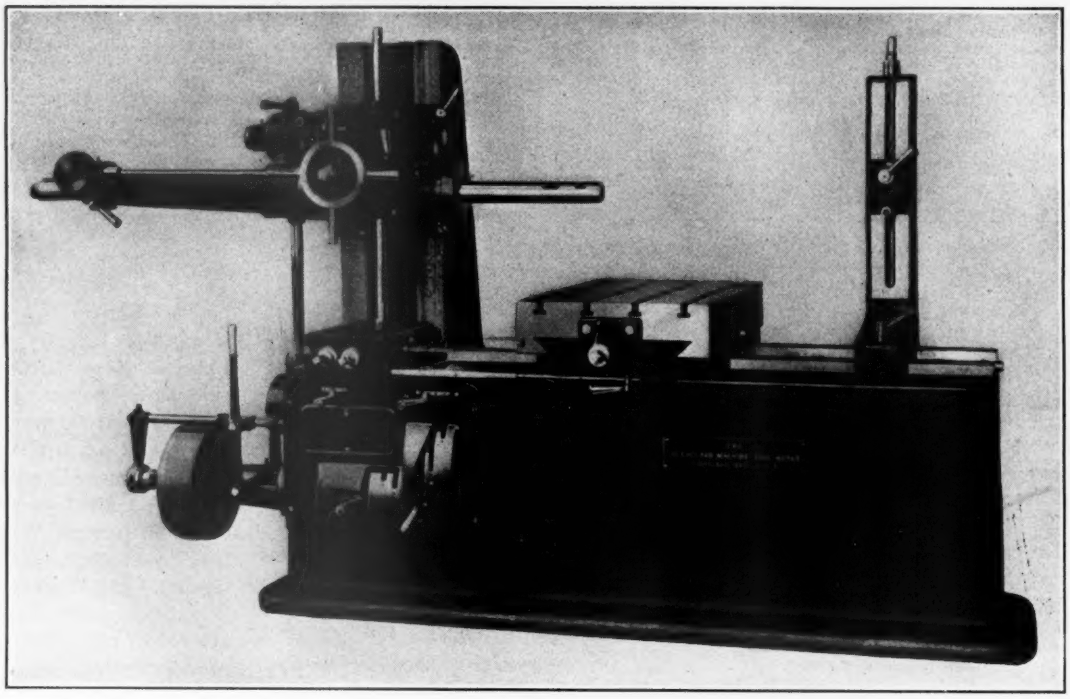
Tank	Water Bottom
Wheels, diameter	37¼ in.
Journals, diameter and length	5½ × 10 in.
Water capacity	8,200 gals.
Coal capacity	13 tons

THE EXTENT OF THE HARRIMAN LINES.—One can leave New York on a Southern Pacific Company steamship, transfer to the Sunset Lines at New Orleans, board a Pacific Mail steamer at San Francisco and land at Hong Kong, a total journey of 9,902 miles, without leaving Harriman Lines. On the completion of the lines now under construction between Seattle and Portland, and between Culiacan and Guadalajara, Mexico, a traveler will be able to make a continuous trip on Harriman rails from Seattle, in latitude 47° 30″, to Guadalajara, in latitude 22°, a distance of 3,169.4 miles; or from Seattle to New Orleans, a distance of 3,441.4 miles.—*J. Kruttschnitt before the New York Railroad Club.*

FRICTION METAL SAWS.—An explanation of the manner in which a soft steel disk, revolving at high velocity, cuts hard steel has been sought with the aid of a microscopic inspection. The result corroborates the theory that the material acted upon is heated at the place of contact to the fusing point and then brushed away. The high temperature appears to be confined very narrowly to the point of contact, so that a thin gash is cut. The temperature of the revolving disk does not rise so high because of the large surface area of the disk. The part of the disk in contact is continually changing, while the frictional energy is concentrated on a very small area of the material subjected to its action.—*The Practical Engineer.*



FRAMES—BURLINGTON PACIFIC TYPE LOCOMOTIVE.



CLEVELAND HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

In designing this machine, manufactured by the Cleveland Machine Tool Works, Cleveland, O., ease and convenience of operation have been carefully studied. The spindle runs in solid taper bearings with adjustment for wear and has a face plate to receive large milling cutters for heavy work. It revolves in either the right or left hand direction and may be started, stopped or reversed instantly, this feature being convenient for facing, tapping, milling and other operations. The spindle and back gear drive is located between the spindle bearings. The levers for operating the back gear and for reversing the spindle are located on the head and can be engaged or disengaged while the machine is in operation.

The spindle bar has a traverse of 22 inches and may be fed by power in either direction. It is operated by a pilot wheel on the head for both the hand feed and the quick traverse; when used for face milling purposes it may be securely clamped in position. The platen has a working surface of 20 x 36 in., with a traverse of 24 in. Both the platen and the carriage have micrometer dials on the adjusting screws. The outer support for the boring bar may be easily removed for overhanging work; provision is made for aligning it accurately with the spindle head.

Twelve spindle speeds are provided in geometrical progression, the gear ratio from the spindle to the driving shaft being 7 to 4 in single gears. Sixteen positive feeds are provided, ranging from .005 to .3 in. per revolution of the spindle. The deep box construction of the bed, together with internal ribs, makes a foundation unnecessary. Two chutes are provided which carry away the chips. The machine weighs about 6,000 lbs., occupies a floor space of 11½ x 6 ft. and has a maximum distance from the face plate to the out-board support of 4 ft. 6 in.

OXY-ACETYLENE WELDING OF FIRE-BOXES.

At the recent convention of the International Boiler Makers' Association, M. S. Courtney, general boiler inspector of the Great Northern Railway, St. Paul, Minn., described the process of oxy-acetylene welding in use on the Great Northern Railroad. Patches are now welded into the side sheets of fire-boxes by the oxy-acetylene process in comparatively short time with gratifying results, and thus far the work has been absolutely satisfactory, with no sign of leakage. The oxygen is generated from chloride of potash and dioxide of manganese. The acetylene generator is one which was designed by Mr. Emerson, who also developed the blow torch which is used. By means of this process fire-boxes are now cut out 50 per cent. faster than by the former method of cutting out rivets, stay-bolts, etc.

In welding patches in fire-box sheets, the defective part is first cut out with the torch, and the edge of the side sheet is beveled to an angle of 60 degrees. The edge of the patch is also beveled to an angle of 60 degrees, and then the patch is placed in position so that the two beveled edges form a V-groove, into which the additional metal is allowed to flow during the welding process.

Much of the success of this process depends upon the kind of metal used in welding. At first, spring steel about 3/16 inch diameter was used, but this was found to be too hard. Then vanadium steel was tried and gave promise of good results, but was finally found to be too hard after being heated to a welding heat. Finally Swedish iron was used with good results. This iron is fibrous and tough; it is also ductile, and in order to use it in welding it is unnecessary to heat the adjacent plate at a great distance either side of the joint. This is an important point, as heating an excessive area of the joint causes local expansion, which interferes with the placing of the patch.

It is now the intention to equip all of the Great Northern boiler shops with oxy-acetylene welding apparatus, and to use it, not only for boiler work, but also for repairing castings and other machined parts. Up to date there are from twenty-five to thirty engines on this road which have welded patches in the fire-box, some of them as large as 30 by 36 inches, and those engines have given no trouble. In some engines which gave trouble by leakage at the longitudinal seam in the fire-box, a strip about 9½ inches wide the whole length of the seam was cut out by means of the torch and another sheet welded in, thus doing away with the riveted joint. This job, too, has proved entirely satisfactory and has given no trouble.—*The Boiler Maker.*

The belt speed for maximum economy is between 4,000 to 4,500 feet per minute, but for main-drive belts it can be considerably higher.

SHOP TELEPHONE SYSTEM.

Most of the large modern railway shop plants are very thoroughly equipped with a local telephone service and a very short experience with it is sufficient to show that the value of the different foremen and superintendents is very decidedly increased as a direct result of the telephone service. In large shops each foreman now has but few reasons for leaving his office or its immediate vicinity, or for holding any piece of work because of the lack of full and explicit instructions as to what is to be done with it. The results of the telephone service are noticeable not only in much less spoiled work, but also in the work of each gang being better directed and moving more smoothly and at a higher rate of speed than was the case in the older shop. In fact, the telephones quickly become so much a part of the shop system that the whole organization and scheme of work would have to be altered if they were to be removed, and beyond doubt the efficiency of the shops as a whole would be lowered very decidedly in such an event.

Very few of the older and smaller shops have been equipped with a telephone system which puts each and every foreman in direct communication with the shop superintendent or master mechanic, as well as with each other, although these men, because of the diversified duties falling upon them in a small shop, really have a greater need of a telephone than do highly specialized departments of a big shop. There have been very good

reasons for this condition at places where there are not a sufficient number of connections to make a central switchboard advisable, in that there has not been, until within the last few years an entirely satisfactory intercommunicating system of telephone. The demand for local telephone service of this kind has been so great that the efforts of some of the largest electrical companies and telephone experts have been directed along these lines so that at present it is possible to obtain at a very reasonable expense an entirely automatic local telephone service for a shop plant or division headquarters which can have, as desired, any number of communications, up to 31. The illustration shows one of these telephones on a circuit equipped with twelve connections, which is manufactured by the Western Electric Company, 463 West street, New York. The operation of the system is entirely automatic and to make a call all that is necessary is to simply push the button opposite the name of the station desired and remove the receiver from the hook and place to the ear.

Systems of this kind are manufactured by this company in a number of different styles, which include desk phones in several arrangements, as well as wall phones. An extra equipment is sometimes included, consisting of a general superintendents' call by means of which a special bell can be rung at all offices throughout the system for the superintendent or master mechanic, who is somewhere about the plant and is wanted immediately. Full descriptive matter of the features of this type of telephone and prices of equipment of various sizes can be obtained from the manufacturers.

DECAY OF LUMBER.

Decay is caused by a number of species of fungi. These are low plants which grow in the wood fiber, just as weed plants grow in the soil. The spore of these fungi are produced in punks or toadstools, which grow on boards or old sticks. These spores germinate in season checks or on the surface and grow into the timber. The fungus extracts certain elements from the wood fibers, and when it has extracted a sufficient quantity, a new punk or toadstool grows out from the outer surface of the timber. After the fungus has grown in the wood, we say the wood has decayed. I wish to call particular attention to the fact that in many of the woods which we are now using, particularly the so-called inferior woods, the sap wood decays with great rapidity. The decay takes place apparently inside of the stick, that is, it is rarely visible on the outside. This is due to the fact that the fungus, in order to grow, requires a certain amount of water, heat, oxygen and food supply. The outer surface of the stick dries out rapidly, and very shortly after it is cut, there is not enough water in the outer portion to sustain life. The fungus spores thereupon find their way to the bottom of season checks, where they find enough water and produce decay in the inner portion of the stick. This is getting to be an extremely serious problem, the gravity of which should be realized by those responsible for the lumber and timber in railroad operations. The appearance of a punk or toadstool on a piece of wood may always be taken as an indication that the inside is decayed. There are, to be sure, certain forms which grow on sugars, and on the outside of boards, which are harmless, but these are few in number. The chief point which I wish to emphasize in mentioning the decay is the fact that these fungi cannot grow in wood without a certain amount of water.—*Hermann Von Schrenk before the Railway Storekeepers' Association.*

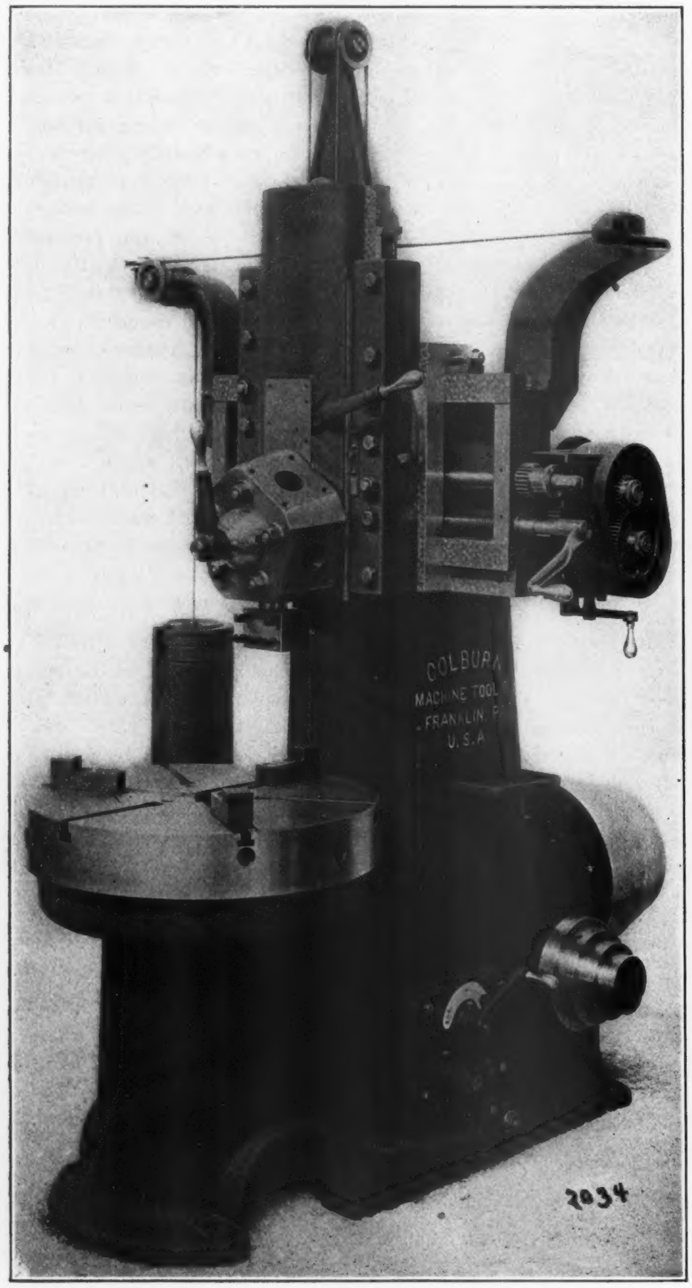
THE PENNSYLVANIA TUNNELS AT NEW YORK.—The Pennsylvania Railroad has completed the construction of its tunnels under Bergen Hill and the Hudson River into its station at Seventh avenue and Thirty-third street, New York City. The work of electrification, signals and track laying will be pushed forward as vigorously as possible. This culminates the construction work on the first two tunnels to be built for trunk line service under the Hudson River. The first excavation was begun May 12, 1905. The north tunnel was joined on September 12, 1906, and the south tunnel on October 9, 1906. The tunnels under Bergen Hill were connected on May 7, 1908, and April 11, 1908, respectively. These two tunnels, which are 23 feet in exterior diameter, are lined with 2 feet of concrete. They extend from the Hackensack portal under Bergen Hill to the Weehawken shaft, a distance of 1.2 miles, and from the latter shaft to Ninth avenue, New York, 1.4 miles. In the course of their construction, 501,995 cubic yards of material have been excavated. For blasting, 1,201,000 lbs. of powder have been used.

CONSERVATION OF COAL.—There is not much consistency in exploiting the conservation of coal when operators at certain seasons are compelled to dump hundreds of thousands of tons of screenings or fine coal on the ground, because the trade at that season does not want that particular grade of coal. I believe that we should confer very closely with the coal producer, to the end that in some instances a compromise grade, possibly, somewhere between lump and mine run may be purchased, and burned on our locomotives, preventing the necessity for the operator dumping fine coal on the ground, which in the majority of cases is practically lost, or, in other words, the revenue that he derives from the sale of that subsequently picked up barely offsets the expense of throwing it down and picking it up. You all know that coal stored on the ground deteriorates very rapidly. A further advantageous disposition of fine coal can be made by the extension of the briquetting industry.—*President Eugene McAuliffe, The International Railway Fuel Assn.*

A NEW 30-INCH VERTICAL BORING MILL.

THE COLBURN MACHINE TOOL CO.*

A number of valuable improvements are incorporated in the vertical boring mill shown in the accompanying illustration. The most noticeable new feature is in the design of the head stock, or main drive, which is all enclosed in a separate box or frame and can be quickly detached from the main frame or housing. This construction makes it most convenient for repairs and also presents an opportunity for building the machine with greater accuracy and better workmanship, as the fitting up of this most important part of the boring mill can be done entirely separate from the massive sections of the machine. Another new feature is seen in the foot-brake, for quickly stopping the table at any desired position.



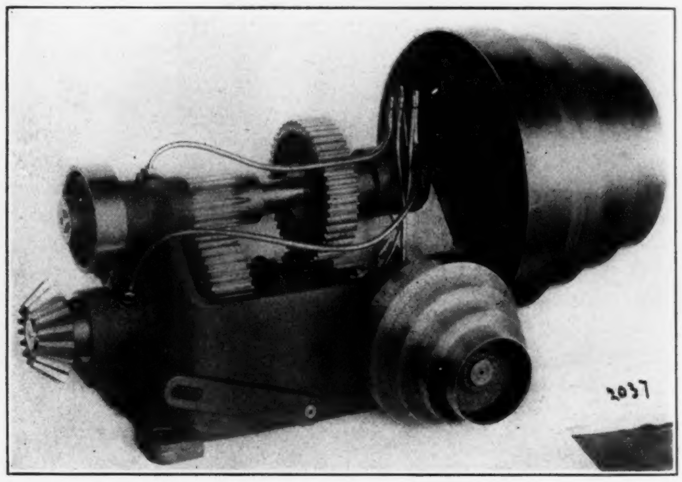
THIRTY-INCH VERTICAL BORING MILL.

The turret head on the cross bar is five sided and set at an angle of 8 degrees, which gives it plenty of clearance for large tools. The turret slide can be swiveled at any angle up to 30 degrees either side of the center, and a graduated scale with a pointer is provided for accurately indicating the depth of cut. The main spindle has 16 changes of speeds and there are eight different rates of feeds, vertically and horizontally. The head stock is driven by a four-step cone pulley belted to a two-speed counter-shaft. On the shaft to which the cone pulley is keyed are keyed a gear and pinion which mesh with gears below, revolving loosely on the second shaft. Between these two gears is a tooth clutch splined to the shaft, which can be interlocked with either gear. This gives two speeds from the gearing, and with a four-step cone gives eight speeds in the head stock, the two-speed counter-shaft increasing this to sixteen.

Lubrication has been given special attention, and in the head stock all bearings are lubricated from one oil box by means of brass tubing leading to the journals. The vertical driving shaft is lubricated by a large oil pocket filled with oil, from which a wick carries the oil to the top of the bushing, where it makes the lubrication of this important bearing entirely positive. A storage reservoir, connected to the smaller one around the bushing, is provided, and thus assurance is almost positive, that the bearing will never become dry.

* Franklin, Pa.

FAILURES.—Few fields of study are more fruitful of results and lead to more genuine progress than a study of the causes of failures. Such studies may be unpleasant and disagreeable, they may at times be even disheartening, but the man who would make substantial advances must heed the lessons which his failures teach. Faraday, who spent his life in experiment, used to say that he learned more from his failures than he did from his successes. And it is not difficult to see why this should be so. When an experiment or a construction has proved successful we are naturally most interested in the result, and do not usually spend time and thought and study over the details which have led to our success. On the other hand, if our experiment or construction is a failure, the cause of the failure is immediately sought for, every detail is questioned, and it is this study of the details which broadens our knowledge. Quite in line with Faraday's statement is the rather more homely phrase, with which you all are doubtless familiar, and which we remember to have seen somewhere in engineering literature, that "the scrap heap is the place to learn."—*Dr. Chas. B. Dudley, American Society for Testing Materials.*

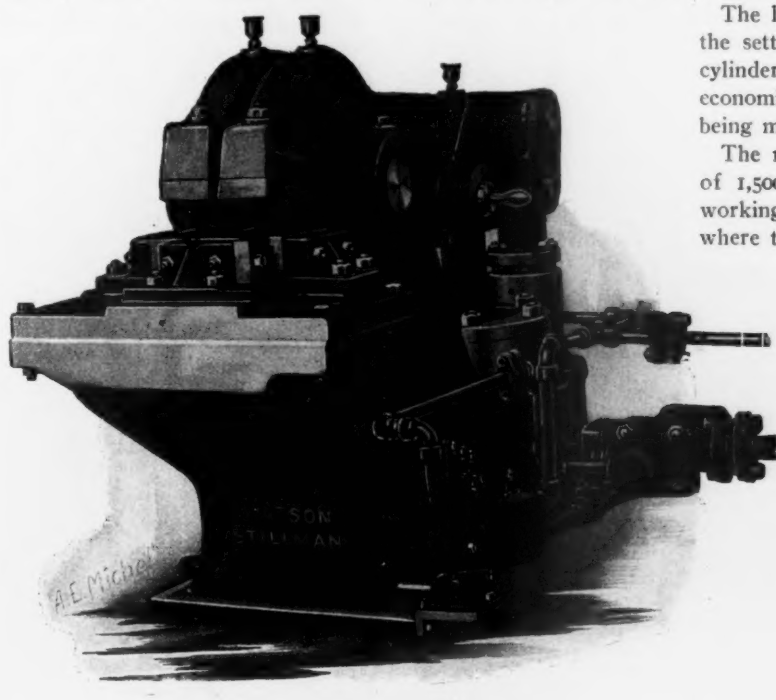


SEPARATE MAIN DRIVE—OIL BOX REMOVED.

BUILDING UP THE EFFICIENCY OF A SHOP.—Every bit as great care should be taken in getting new men and apprentices as in getting new machines, and they should not only be started right, but their development provided for. Machines inevitably depreciate, even 10 per cent. per year, and more as improved machines are invented which render existing machines out of date; but men, if properly cared for, may appreciate in value many hundred per cent. An organization can never become strong unless it has some well thought out plan for recruiting and raising the level of the men in the ranks.—*Prof. H. Wade Hibbard before the St. Louis Railway Club.*

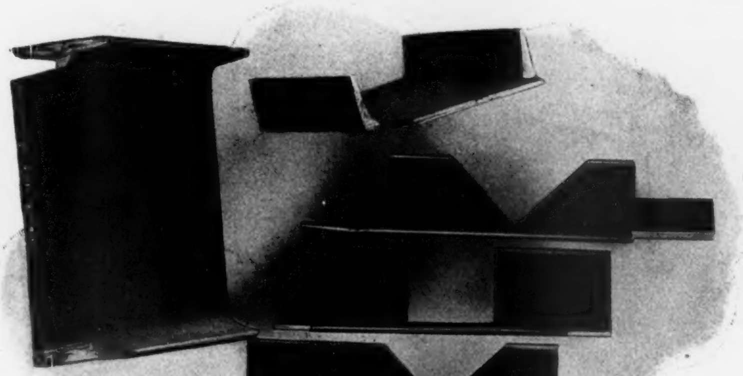
HYDRAULIC COPING MACHINE.

The machine shown in the illustrations is manufactured by the Watson-Stillman Co., 50 Church street, New York, and has been successful in greatly reducing the time, labor and power consumption in trimming structural shapes, small pieces of plate metal, bar iron, etc. It has shown itself eminently fitted for use in car building or repair, boiler and locomotive shops or wherever splices, connections or cuts similar to those shown in the illustrations must be made.

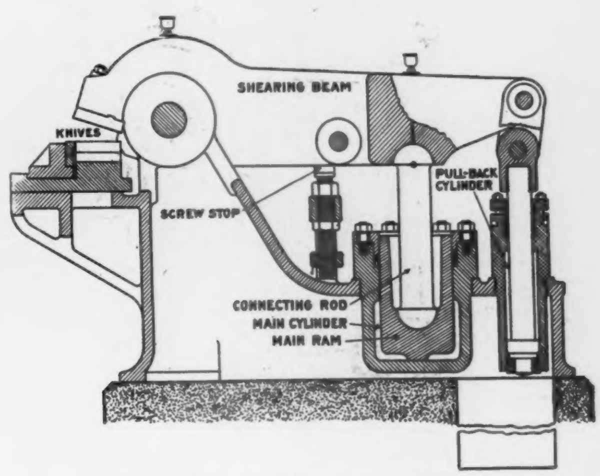


HYDRAULIC COPING MACHINE.

It consists essentially of a heavy steel beam hydraulically operated from the rear to concentrate extreme power upon shearing knives in front. The forward end of this lever is so divided and constructed that by the removal of a pin the half containing the upper right hand knife may be thrown out of action and the knife left standing at its upper limit. The divided upper knife also permits the insertion of a web or flange when it is desired to shear close to those parts, and is very handy in certain types of cuts, smaller than the combined area of both knives. The lower or stationary knives are bolted to the plates in such a manner that those on any side may be removed without disturbing the others.



SAMPLES OF WORK PERFORMED BY THE HYDRAULIC COPING MACHINE.



SECTION OF HYDRAULIC COPING MACHINE.

This construction offers a large number of cutting combinations, and as the change can be made from any one combination to another in less than one minute's time the machine will be found very convenient in making cuts at odd angles.

The machine is operated by a simple foot lever. All that is necessary to make a clean smooth cut is to hold the section in proper position and press down on the foot lever until the upper knives descend to the bottom of their stroke. The knives rise the minute the foot pressure is removed and the machine is ready for the next cut. Reference to the sectional illustration will show the arrangement of the parts.

The length of lever stroke is adjustable, being determined by the setting of a screw stop between the main bearing and the cylinder. It is thus possible to reduce the stroke to be most economical of power while a large number of similar cuts are being made.

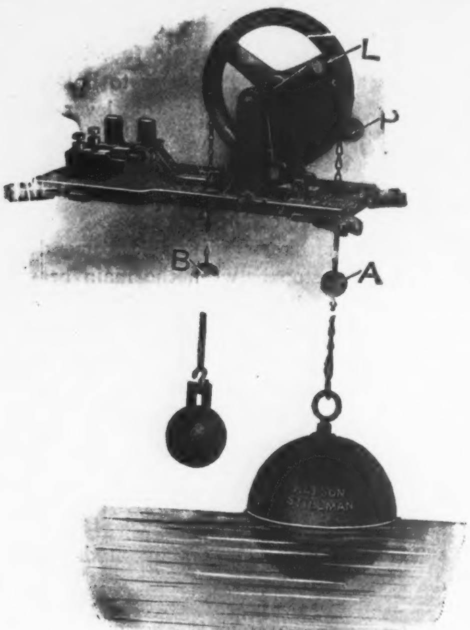
The main cylinder is ordinarily built for a working pressure of 1,500 pounds per square inch, but can be obtained for any working pressure between 1,000 and 3,000 pounds. In shops where the line pressure is below these figures an intensifier may be employed to produce a suitable operating pressure.

The machine weighs 4,700 pounds and has a 9-in. diameter ram.

A NEW AUTOMATIC TANK SWITCH.

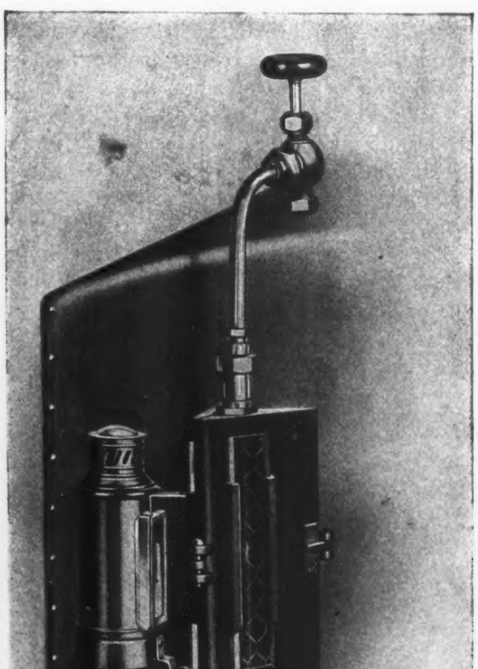
This device is claimed to be a decided improvement over previous devices for automatically maintaining the water level between desired limits in open tank or sump systems. The construction permits it to be placed on top of the tank or sump cover, and allows any desired variation in water level to be carried without relocating the electrical apparatus. When the switch is placed on top of the tank there is no necessity for boring a hole into the side of the tank and there is no danger of the switch flooding and becoming short-circuited.

The operation of the Watson-Stillman switch in starting and stopping the motor is dependent upon the movement of a falling hammer, the movement of which in turn is governed by a freely suspended copper float nearly counterbalanced by a cast iron ball. Referring to the illustration of the interior mechanism, which is shown arranged for tank service, the two small wooden balls on the chain are adjustable and their position determines the variation of water level between operations of the pump. The switch is shown as when the pump is in operation. As the float rises, the ball A comes into contact with the projection P on the hammer and carries it past the center. The hammer then falls to the other side of the pulley shaft by gravity, and in doing so, the lug L strikes a projection on the switch and disengages the knife, thus stopping the motor and pump. The switch movement is quick. There is no chance for arcing, and as the hammer remains in contact with the switch arm,

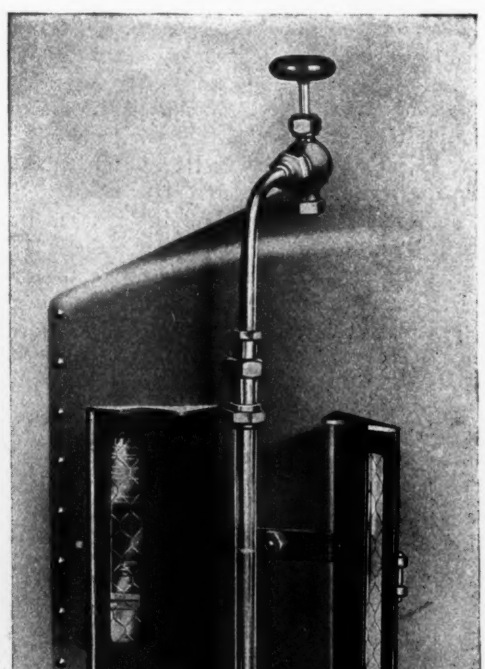


NEW AUTOMATIC TANK SWITCH.

there can be no rebound. The hammer holds the switch arm in this position until the falling of the water level brings the other wooden ball B into contact with the hammer lug, which reverses the hammer, throws the knife into contact and starts the pump again. The wheel acts merely as a carrier for the



"POSITIVE" WATER GLASS GUARD—CLOSED.



"POSITIVE" WATER GLASS GUARD—OPENED.

copper chain. It plays no other part in the operation of the switch.

As arranged for draining sumps, the copper float and iron ball are reversed. This reverses the switch action to start the pump when the water level gets too high. Dampness will not affect the working qualities of the switch when it is placed in the pit.

The knife arm is thoroughly insulated from every other part of the switch and the two contact points are mounted upon a slate block. A suitable opening is provided in the body for inserting the tube and making the connection to the binding posts. No parts of the switch need oiling or other attention. The shaft is bronze to prevent corrosion and all parts are extra strong. All working parts are enclosed in a heavy cast iron case which protects them from the weather and from external injury.

This switch may be had single or double pole and for all ordinary currents and voltages. It is made by the Watson-Stillman Co., 50 Church street, New York.

"POSITIVE" WATER GLASS GUARD

The water glass guard, shown in the illustrations in both a closed and open position, is known as the "Positive" and is manufactured by the American Steam Gauge & Valve Manufacturing Company, of Boston. It consists of two frames, or doors, of malleable iron swinging on hinges, attached to a bracket secured to the boilerhead by studs. The doors completely cover the water glass and stand at such an angle with the boilerhead that the light is reflected through the sight glasses. These glasses are made of heavy plate glass with woven wire insert, and placed in slots in each door directly in front of the water glass, giving a view of the water level at all times.

The following claims are made for this guard: It will protect the enginemen in case the water glass breaks, thus eliminating claims for injuries received from this cause and the accompanying law suits. The guard is practically a permanent fixture on the boilerhead and cannot be lost or thrown away. It lasts as long as the boilerhead and costs nothing for renewals. Train delays caused by inability of enginemen to locate and shut off

cocks are done away with as the cocks can be found immediately and closed with the bare hand with the new guard. Time is saved when renewing water glasses, as there are no parts to remove or lose. After the glass is applied cocks may be opened quickly with no danger to workman. The guard does not necessitate a change in water glass fixtures and may be applied at a very small cost.

FIRING BRIQUETS.—The work of the fireman is reduced by the use of briquets. Their uniform size makes the handling easier; it is easier to keep up steam and only necessary to fill up the holes in the fire without leveling. No slicing is necessary as is usual with eastern coals. The comparative absence of clinker, when briquets are properly fired, is a big advantage in forcing the boiler for heavy grades or higher speed.—*C. T. Malcolmson before The International Ry. Fuel Assn.*

PERSONALS.

Charles J. McNulty has been appointed master mechanic of the Salt Lake & Ogden Ry.

J. G. Neuffer has resigned as superintendent of machinery of the Illinois Central R. R.

John Tonge, master mechanic of the Minneapolis & St. Louis Ry., at Minneapolis, Minn., has resigned.

Frank Lane has been appointed the electrical engineer of the Wabash R. R., succeeding W. A. Hopkins, resigned.

H. P. Latta, general foreman of the International & Great Northern Railway shops at Palestine, Tex., has resigned.

J. B. Buker has been appointed superintendent of the car department of the Illinois Central R. R., with office at Chicago.

J. E. O'Brien has been appointed mechanical engineer of the Northern Pacific Railway, succeeding W. L. Kinsell, resigned.

R. W. Bell has been appointed superintendent of machinery in charge of the locomotive department of the Illinois Central R. R., with office at Chicago.

William Smith, of the Pittsburgh & Lake Erie Railroad, has been promoted to general foreman of the machine shops at McKees Rocks, Pa.

E. B. Van Akin has been appointed the road foreman of equipment, St. Louis division of the Chicago, Rock Island & Pacific Ry., with office at Eldon, Mo.

James Hoflich, roundhouse foreman, of the Illinois Central R. R., at East St. Louis, has been appointed general foreman, succeeding Mr. Walker, promoted.

W. L. Kinsell, mechanical engineer of the Northern Pacific Ry., has resigned to accept a position with the Westinghouse Machine Company at East Pittsburgh.

D. J. Redding, master mechanic of the Pittsburgh & Lake Erie R. R., has been appointed assistant superintendent of motive power and his former office has been abolished.

F. J. Barry has been appointed the general inspector in charge of air brakes, steam heat and lighting of the New York, Ontario & Western R. R., with office at Middletown, N. Y.

G. S. Turner, general equipment inspector of the Southern Railway, has resigned to become the southern representative for the American Locomotive Sander Co., Philadelphia, Pa.

Joseph Walker, general foreman of the East St. Louis shops of the Illinois Central R. R., has been appointed to succeed Mr. McIntosh as master mechanic, with office at East St. Louis.

Robert F. McKenna, master car builder of the Delaware, Lackawanna & Western R. R., at Scranton, Pa., has resigned, and will retire entirely from railroad life.

J. R. Radclifte, who has had charge of the apprentice work at the McKees Rocks shops of the Pittsburgh & Lake Erie R. R., has been made foreman of the machine shop, succeeding Mr. Smith.

W. L. Allison, mechanical engineer of the Atchison, Topeka & Santa Fe Railway, with office at Chicago, has resigned to accept a position with the Franklin Railway Supply Company, New York City.

H. W. Burkheimer has been appointed the master machanic of the New Orleans Great Northern R. R., with office at Bogalusa, La., succeeding F. Schledorn, acting master mechanic, resigned.

C. L. Dougherty has been appointed the acting mechanical engineer of the Cleveland, Cincinnati, Chicago & St. Louis R. R., with office at Indianapolis, Ind., succeeding B. D. Lockwood, resigned.

W. A. Hopkins, electrical engineer of the Wabash R. R., at Decatur, Ill., has resigned to accept a position as electrical engineer of the Safety Car Heating & Lighting Co., with headquarters at St. Louis, Mo.

W. B. Embury, master mechanic of the Oklahoma and Pan Handle divisions of the Chicago, Rock Island & Pacific Ry., with headquarters at Chickasha, Okla., has had his jurisdiction extended to include Sayre Station.

J. J. Burns, general foreman of the Chicago & Alton Railroad at Chicago, has been appointed general foreman of cars with authority over the entire Alton system, with headquarters at Bloomington, Ill. Mr. Burns succeeds, with extended jurisdiction, J. H. Milton, resigned.

CATALOGS.

VENTILATORS.—The Globe Ventilator Company, Troy, N. Y., is issuing a new catalog illustrating its ventilators as applied to buildings of all classes and showing a number of different styles and sizes.

ASH PAN CLEANER.—The Talmage Mfg. Co., Cleveland, Ohio, is issuing a small leaflet devoted to illustrations of the Talmage system ash pan cleaner, which can be applied to any locomotive ash pan and make it entirely self-clearing.

A-B-C-ENGINEERING.—The Hill Clutch Company, Cleveland, Ohio, is issuing the first of a series of booklets under the above title. This is devoted to line shaft bearings in general and contains some very interesting matter on this subject.

NUT AND BOLT FASTENERS.—A booklet has been received from The American Nut and Bolt Fastener Company, P. O. Box 996, Pittsburgh, Pa., explaining the advantages of the Bartley fasteners and illustrating various types suitable for use on cars, locomotives and track.

NO. 930.—The Cleveland Twist Drill Company is issuing a leaflet descriptive of the new high speed "flatwist" drill with a "Paragon" flat taper shank, which was illustrated on page 343 of the August issue of this journal. The leaflet contains a brief description and full price list.

COMMUTATING POLE MOTOR.—Bulletin 4679, from the General Electric Company describes a new line of commutating pole constant speed motors. They are made in both slow and moderate speed types, in capacities of from 20 to 250 horse power in the former, and 30 to 350 in the latter. They may be operated entirely open, semi-enclosed, or totally enclosed, and may be installed on the floor, wall or ceiling.

BULLSEYE LOCOMOTIVE LUBRICATORS.—The Detroit Lubricator Company, Detroit, Mich., is issuing a very attractive booklet containing a full description of the various types and sizes of the bullseye locomotive lubricator, together with valuable information relative to installation, operation, care,

etc. The book is thoroughly illustrated and will prove to be of much interest and value to all locomotive men, particularly engineers and roundhouse men.

Log Log Duplex Slide Rule.—Keuffel & Esser Company, 127 Fulton street, New York, is issuing a leaflet describing a new slide rule which has been designed to furnish solution of many problems beyond the range of the ordinary slide rule. It will do the same work that the usual rule performs and in addition will extract any root or raise to any power, integral or fractional. Hyperbolic logarithms are read direct, sines, tangents and co-tangents are given from one second to 90 degrees.

Belting.—The New York Leather Belting Company, 51 Beekman street, New York. issues a monthly publication known as *The Phoenix*. This magazine contains technical discussions, with illustrated descriptions of transmission problems. It shows comparative tests of the efficiency of various types of belting for different classes of machinery. The proposition of reducing replacement costs in the railroad shops was treated in a recent issue of this publication. Copies may be obtained without charge on application.

Brushes.—The Wolfe Brush Company, Pittsburgh, Pa., is issuing catalog No. 58, which contains 126 pages devoted to illustrations, brief description and price lists of the very large variety of brushes manufactured by it. These include scrubbing brushes, dusters, vacuum cleaning brushes, etc., as well as paint brushes of all kinds. Many brushes are shown which are designed specially for railroad use and this catalog should be available in the car cleaning as well as the paint department. A very complete index is included.

Fire Proof Siding.—The H. W. Johns-Manville Co., 100 William street, New York, is issuing a little booklet which draws attention to the many valuable qualities of "Asbestoside," which is a fire proof, weather proof siding that never needs painting. It is claimed to be the most durable, weather resisting material known, and will last as long as the building stands. It is not affected by acids, gases or fumes and is an excellent non-conductor of heat and cold. The booklet shows some most interesting tests that have been made with this material.

Ballata Belting.—A very interesting pamphlet entitled "From Forest to Factory," is being issued by the New York Leather Belting Co., 51 Beekman street, New York. It contains a full description of the manufacture of the Victor-Ballata belting, explaining how the valuable qualities of Ballata for belting purposes were discovered and how this gum is gathered in the jungles of the tropics and the processes it passes through in being prepared for use. This type of belting has a number of ideal qualities and is being successfully used under some of the most trying conditions.

Articulated Compound Locomotives.—At the December, 1908, meeting of the American Society of Mechanical Engineers, C. J. Mellin, consulting engineer of the American Locomotive Company, read an extensive paper on "Articulated Compound Locomotives." An abstract of this paper appeared on our January issue, page 14. The paper in full, completely illustrated, has just been published in pamphlet form by the American Locomotive Company, 30 Church street, New York City. It includes also extracts from the discussion as well as half-tone illustrations and data concerning a number of important locomotives of this type.

Electrical Machinery.—Among the bulletins recently issued by the General Electric Company is No. 4675, which describes and illustrates a new single phase induction motor designated as type RI. The bulletin shows various applications to this motor; illustrates and describes controllers for use in connection with it and contains other data, including diagrams of connections. Bulletin No. 4668 describes the latest railway motor being built by this company, which is of the box form type and is equipped with commutating poles, mica insulated brush holders and removable armature shaft. These motors are 50 h. p. capacity and are designed for operating on a 600 volt circuit. The bulletin contains lists of gear ratios and gives characteristic curves, as well as dimension diagrams of the motors.

Chain Belts.—The Chain Belt Co., Park street and 11th avenue, Milwaukee, Wis., is issuing its general catalog No. 37, a cloth bound book containing 302 pages, and provided with a comprehensive index. This company manufacture elevating, conveying, and concrete machinery of all kinds and the catalog is very largely given up to most excellent illustrations of its products, both in operation and in their detailed construction. Chain belts of practically every conceivable design and size are shown, price lists being included. The catalog also contains an extensive section on sprocket wheels, clutches, gearing, etc. Many special attachments for hoisting and conveying machinery are also included. The catalog is most complete and is very attractive in its make-up.

Silent Running Flexible Gearing.—Under this title the Morse Chain Company, of Ithaca, N. Y., is sending out its machine tool bulletin No. 8. The Morse silent-running high-speed chains are briefly described and a large number of half-tone illustrations are presented showing various applications of it to machine tool drives. In connection with each illustration the following data is given: Horse power of motor, r. p. m of motor and driven shafts, distance between centers, size of sprockets and chain, and speed in feet per minute. The illustrations include applications to lathes, boring mills, shapers, gear cutters, cold saws, punch and shear, rack cutting machine, grinding machines, screw machine, horizontal cylinder boring machine, blower, bending rolls, milling machine, angle shear, forging machine and bolt and pipe threader.

NOTES

American Steam Gauge & Valve Mfg. Co.—The address of the Chicago office of this company has been changed to 130 North Jefferson street from No. 7 South Jefferson St.

The Asbestos Protected Metal Company has just completed plans for an addition to its manufacturing plant at Canton, Mass., and also for the extension of its head office building at the same place.

Crocker-Wheeler Co.—A new branch office of the above company will be opened in the Ford Building, Detroit, Mich., about September 10, and will be in charge of Chas. W. Cross as manager.

Westinghouse Machine Company.—F. C. Armstead, supervising engineer of the stoker department of the above company, who for a number of years has been located at East Pittsburgh, has removed his headquarters to Attica, N. Y., where the stokers are manufactured.

Grip Nut Company.—The Chicago offices of this company have been removed from 1590 Old Colony Bldg. to 575 Old Colony Bldg., where much larger quarters are occupied. It is announced that the universal window fixtures and universal deck sash ratchets are to be used on the fifty new passenger cars now being built for the Baltimore & Ohio Railroad.

Colburn Machine Tool Co.—After September 1 the above company will be represented in the Chicago territory by The E. L. Essley Machine Co., 62 West Washington St., Chicago. Charles L. Robinson, formerly superintendent of the plant of this company at Franklin, Pa., will be associated with The Essley Company as special representative and expert. A representative line of boring mills will be carried in stock in Chicago and will be exhibited in operation.

Manufacturers Publicity Corporation.—Benjamin R. Western and W. Hull Western, respectively proprietor and manager of the Manufacturers Advertising Bureau, New York, associated with Walter Mueller and W. H. Denney, respectively president and manager of the Banning Company, New York, have organized the Manufacturers Publicity Corporation, with offices at 30 Church street, New York, and the advertising interests of clients heretofore directed by the above mentioned companies will be in charge of the Manufacturers Publicity Corporation.

B. F. Sturtevant Co.—The above company, having a capital of $500,000, has been reorganized and recapitalized. The new corporation is organized under Massachusetts laws with $1,250,000 6% cumulative preferred stock and $1,250,000 common stock. The stock has all been taken by a few of the large owners. John Carr is president, Eugene N. Foss is treasurer, and E. B. Freeman has been elected general manager. The increased capitalization represents capital expenditures during the past year, largely in the erection of a new plant in Hyde Park which cost over $1,500,000.

Curtis & Curtis Co.—Roderick Perry Curtis, president of the above company, died on August 9 at Southport, Conn., as the result of an automobile accident which occurred several weeks before. Mr. Curtis formed the firm of Forbes and Curtis in 1882 to manufacture the Forbes patent die stock. This company existed until 1887, when Mr. Forbes' interests were taken by Lewis B. Curtis, and the firm of Curtis & Curtis continued the business. In 1900 the firm was incorporated under its present name. Mr. Curtis was president and secretary at the time of his death. He was very prominently connected with many social, literary and athletic associations in New York and Connecticut.

McGraw-Hill Book Company.—The book departments of the McGraw Publishing Company and the Hill Publishing Company have consolidated under the corporate name of the McGraw-Hill Book Company, with offices at 239 West 39th street, New York. This consolidation brings together two of the most active publishers of technical books in the country. The new company takes over the book departments of both houses with a list of about 250 titles, both industrial and college text books, covering all lines of engineering. It will continue as well the retail, importing and jobbing business of the two houses. The officers of the new company are: President, John A. Hill; Vice-President, James H. McGraw; Treasurer, Edward Caldwell; Secretary, Martin M. Foss.

Dodge Mfg. Co.—The 20th anniversary of the Dodge Mutual Relief Association, made up of the employees of the above company, at Mishawaka, Ind., was celebrated on July 31. This association is a voluntary one and the dues are exceptionally small, being but five cents a week for employees whose earnings exceed $6.00 per week, and half of this amount for those whose earnings are less than $6.00. The benefits in the first case are eighty cents a day and in the second forty cents, and cover a period of thirteen weeks in any year. Death benefits of $50 and $25 are paid. All dues are suspended when the funds on hand amount to $500, and are resumed when they get as low as $300. All of the 2,000 employees of this company are members of this association, and during its twenty years' existence, over $15,000 has been distributed.

THIRD ANNUAL CONFERENCE OF THE APPRENTICE INSTRUCTORS.

NEW YORK CENTRAL LINES.

The apprentice instructors of the New York Central Lines held their third annual conference* at the Beech Grove shops of the Big Four System on Friday, September 3rd. In addition to C. W. Cross, superintendent of apprentices, and his assistant, Henry Gardner, all of the drawing and shop instructors were present with the exception of Mr. Middleton, of St. Thomas. Following are the names of the instructors at the various shops:

Drawing Instructor.	Shop Instructor.	Shop.	Number of Apprentices.
A. L. Devine	G. Kuch, Jr.	West Albany (N. Y. C.)	104
H. S. Rauch	W. F. Black	Oswego (N. Y. C.)	24
G. Kuch, Sr.	E. Kennedy	Depew (N. Y. C.)	75
F. Deyot, Jr.	F. Deyot, Sr.	East Buffalo (N. Y. C.)	13
C. A. Towsley	M. T. Nichols	Elkhart (L. S. & M. S.)	64
R. M. Brown	H. J. Cooley	Collinwood (L. S. & M. S.)	121
Benjamin Frey	R. W. Middleton	St. Thomas (Mich. Cen.)	34
C. P. Wilkinson	C. T. Phelan	Jackson (Mich. Cen.)	46
A. W. Martin	John Buehler	Beech Grove (Big Four)	47
V. J. Burry	Frank E. Cooper	McKees Rocks (P. & L. E.)	36
		Total.......	564

Appropriate resolutions were drawn up concerning the death of Claude M. Davis, formerly instructor of apprentices at the Beech Grove shops and later connected with the apprentice department of the Santa Fe system.

Address of Welcome.—In the absence of Mr. Garstang, superintendent motive power, M. J. McCarthy, superintendent of the Beech Grove shops, addressed the conference and welcomed them to Beech Grove. In speaking of the work of the apprentice department Mr. McCarthy said: "It is hardly necessary for me to dwell on the importance of your methods of apprentice instruction, and the benefits we are obtaining from them, as it is apparent on every side. I feel satisfied that within a very short time, or at the present time, if you please, all that it will be necessary for any young man to say who has taken our instruction courses, and desires employment, is that he has served his apprenticeship on the New York Central Lines."

Following Mr. McCarthy's address a number of letters were read from which the following extracts are taken:

J. F. Deems, General Superintendent of Motive Power.—"This is an important meeting and it will be a memorable one, for, judging from the reports and such observation as I have been able to make, no one connected with the work can fail to feel encouraged at the progress that has been made, and though the period has been short, I believe all can report substantial benefits that have accrued, both to the companies and to the apprentices."

G. M. Basford, Assistant to the President, American Locomotive Company.—"I am watching the progress of your department with the keenest interest and great satisfaction, because of having hoped for so many years to see a large railroad inaugurate an apprentice plan such as you have adopted. To know that this work, which was started March 1st, 1906, now provides for over 550 apprentices in all the branches of the motive power department, gives assurance of a work well founded; the fact that these boys are receiving training in the shop and co-ordinate education in the classroom promises soon to make an impression on the organization which everyone will appreciate.

"It seems clear that the success of the work now depends upon the instructors and upon the future development of the plan. To my notion the word 'training' seems to represent that which is most vital. All large industrial organizations require training of recruits, and nearly all are suffering from lack of it. In the old days, when the boy came into an organization he was placed in the hands of some one who had time to see that he learned that which the owner of the business desired he should know. However, he really learned only as much as the individual with whom he worked desired him to know. The instruction was given grudgingly; it was given by men not accustomed to teaching; it was given to each new recruit differently in accordance with the personal characteristics of the workman who gave the instruction, and the knowledge was imparted as if it was a secret and only for the initiated. Now all this is changed, and the boys may be really trained in accordance with a system, which will develop each individual as far as he can go and prepare the boys to become expert workmen in the shortest possible time. Furthermore, your organization renders it possible to give a training which is not only systematic but enlightened and scientific, free from the effect of possible conflicting ideas of individual workmen; in short, your department is in position to give a New York Central training rather than the unsystematic training of the old days when apprentices received the 'hit and miss' instruction in the shop.

"There was, however, an element in the apprenticeship of the old days, going back to that which was given by the owner of the business direct to the apprentices, which must not be forgotten. *I refer to the personal influence of the master over the apprentices, and the responsibility which the master is supposed to have held in developing the moral side of the boy, his manhood and his citizenship. In this I believe lies the greatest responsibility of your corps of instructors, both in the shop and in the class room. If the boys are trained as are the recruits in the army, you will attain only one part of the success desired. It is not only necessary to produce thinking mechanics, but to produce thinking mechanics who are also good citizens, appreciative of the responsibilities and opportunities of life.*

"I believe that in such movements as this there is a danger to be avoided. It can be avoided if the instructors will bend their efforts to the production of workmen interested in their work and inspired by the desire to be good workmen, leaving the development of leadership to, in a broad sense, take care of itself. Of course, such work would undoubtedly develop leadership. The danger is that the boys would be allowed to believe that the completion of apprenticeship is a guarantee of immediate official position. I firmly believe that the training of leaders is not so much what is wanted to-day as the training of men in the ranks from among whom the strongest leaders are sure to spring."

John Howard, Supt. Motive Power, N. Y. C.—"The results produced by our instructors are indeed quite gratifying. I find that our young men are accomplishing nearly as much in one year's work as they formerly accomplished in two years, which means a great deal to the young men, especially at this time of their lives, and as a result of the work being done by our instructors the young men are able to absorb what would be equivalent under our old methods to two years of knowledge in twelve months."

F. W. Brazier, Supt. of Rolling Stock, N. Y. C.—"In present-day railroading the necessity of reduced cost of operation and

* The proceedings of the first annual conference will be found in the November, 1907, issue of this journal, and those for the second annual meeting in the October, 1908, issue. The organization of the apprentice department and the methods and equipment used by it were described in detail in the June, July, September and October numbers, 1907.

maintenance is of vital importance, together with the necessity for increased efficiency, and the work requires men of more than ordinary experience to handle it to those ends. My one regret is that when I learned my trade as a car builder I was not privileged to have the help of such efficient instructors."

LeGrand Parish, Supt. Motive Power, L. S. & M. S. Ry.—"The object of your work is one well worthy of any man's time. The need for the apprentice school was thoroughly appreciated long before the work was taken in hand and thoroughly systematized. The results so far have been very satisfactory to me personally, and I feel that you are working along the right lines.

"Speaking broadly on the subject, I feel that we should increase our efforts to select as high a class of young men as possible for apprentices in the various trades. The educational benefits which the boys receive at this time are of a very high class, and as we will naturally increase our efficiency in handling decided benefit, and there is no reason why the shops of the New York Central Lines, as a whole, should not, in the course of a few years, be filled with the best lot of mechanics there are in any shops in the country.

"It is probable that all apprentices trained under the system will not be able to secure positions above that of journeyman, but they will certainly make themselves valuable as mechanics, and be able to retain their positions when poorer ones are dismissed."

William Garstang, Supt. Motive Power, C. C. C. & St. L. Ry.—"The apprentice system of instruction is a most important one. It has a far-reaching effect and will have a great bearing on the future mechanics. You have my heartfelt wishes for a successful and instructive meeting."

E. D. Bronner, Supt. Motive Power, Michigan Central.—"I have watched the apprenticeship work with a great deal of in-

MEMBERS PRESENT AT NEW YORK CENTRAL LINES APPRENTICE INSTRUCTORS' CONFERENCE.

M. J. McCarthy, Supt. Shops—Beech Grove (standing).
First row (top), reading left to right: H. S. Rauch, W. F. Black, A. W. Martin, G. Kuch, Sr., Frank Cooper, John Buehler, C. A. Towsley, C. T. Phelan, C. P. Wilkinson, and F. Deyot, Sr. (Second row): R. M. Brown, H. J. Cooley, Benj. Frey, V. T. Burry and F. Deyot, Jr. (Third row): M. T. Nichols, E. Kennedy, C. W. Cross, H. Gardner, G. Kuch, Jr., and A. L. Devine.

the apprentice schools we should increase our efforts to improve the young man who is thoroughly worthy.

"As you are aware, we have tightened up somewhat in our discipline, and I feel that it is necessary. We ought not, under any circumstances, to permit boys to remain in our service as apprentices who do not apply themselves, both in the drawing room and shop, as the boys' success, as well as our own, depends upon individual effort.

"The apprentice instructors, in both the shop and school room, occupy a very important position in relation to the shop organization, on account of the fact that they have the boys directly under their charge. Whenever the mechanical engineer, shop superintendent, or other official, desires to place an apprentice in a position of responsibility, the apprentice instructor should be able to advise him thoroughly as to the boy's qualifications and have a fair idea of what may be expected in his future development in any line of work to which he may be assigned."

L. H. Turner, Supt. Motive Power, P. & L. E. R. R.—"I want to take this opportunity of saying that while I have always felt that much good would be obtained by a systematic education of our apprentices, that I did not realize we would derive such a

terest and pleasure, and the methods which are being employed I know are bringing about splendid results. The work you are carrying on is such as cannot help but lay a splendid foundation for a class of men suitable for any position in the mechanical department of any railroad organization. We do not necessarily expect that they will all become experts, but there is no question whatever but that those who enter into the true spirit of the work will be better mechanics by having had an opportunity of acquiring the training that is being put in their way. The working out of the theoretical with the practical certainly will have to produce good results, and the only suggestion I have to offer for consideration at this time is possibly one in the way of a caution that we do not go too deep into the theoretical part with the boys at first, but rather that the idea not to be lost sight of is the development of a better class of men throughout the shop with a view of placing the ambitious, capable and bright ones in line for advanced positions."

R. T. Shea, Inspector of Piece Work, N. Y. C.—"In reading over your annual report regarding the progress of the apprenticeship department, I notice that you refer to the apprenticeship training working in harmony with the piece-work system. Our

observations are that the apprentices are being instructed along the right lines in regard to the working of piece work and the piece-work organization; in many cases we are using them temporarily to help the piece-work inspectors, giving them an opportunity to know that side of the work, in addition to giving them an opportunity to work piece work on a percentage basis whenever possible, and educating them to our plan of paying for work done rather than for time put in. We feel sure that this will be far-reaching in its effect."

MR. CROSS' ADDRESS.

In his address Mr. Cross spoke in part as follows:

Extension of the Work.—"During the past year, since the second annual conference at the Depew shops, the apprenticeship work on the New York Central Lines has continued to occupy an important place in the affairs of the associated companies and has also been inaugurated on the Erie, Lehigh Valley, and Canadian Pacific Railroads. There is now no hesitation in saying it has gone safely beyond the experimental period and has become a regular department of the railroad business. All the heads of departments, subordinate officers, workmen and apprentices are showing a very agreeable spirit of co-operation. Within the past year a number of apprentices and graduate apprentices have been promoted to positions of responsibility, such as draftsmen, apprentice instructors, inspectors, assistant foremen and foremen.

Graduate Apprentices.—"Particular attention is called to properly taking care of graduate apprentices in a manner to make them useful to the company as well as to properly recognize the ability and faithfulness of the employee. To train an apprentice and not to make use of him when out of his time is to lose the best results of the effort, and yet some of our organizations at the present time are not prepared to make intelligent use of graduate apprentices. The bright boy is blamed for leaving at or before the completion of his term, but the fault is largely due to the failure of his employers to appreciate his true value and to make further progress possible. It is not economy to spend three or four years training a boy and then let him go, and a continuance of such policy will ultimately kill the best apprenticeship system. Nothing less than a complete and radical change of policy is needed in some organizations to fit them both to attract and to hold apprentices.

The Shop Instructor.—"The most noticeable result from the installation of the new apprenticeship system has been the increased efficiency of the working force which must result from the number of workmen, developed through apprenticeship schools and shop instruction, who have been promoted to workmen and positions above that of workmen. This is largely due to the work of the shop instructor, supplemented by the classroom instruction. Under the old system the foreman was expected to see that the boys received proper instruction concerning their work and that they performed it properly. Ordinarily the foreman is too busy to give the boys anything like the proper amount of attention. With the addition of the shop instructor, who has the duty of looking after the boys, the efficiency of the apprentice has been very greatly increased, with a resulting improvement both in the amount and quality of shop work done. There is no question but that the work accomplished by the shop instructors has more than paid for their salaries. The shop foreman, relieved of the care of the boys, can give his time to the administrative features of his department.

Benefits from the Drawing Room Work.—"Another important feature is that the apprentice after he has had a few months of classroom instruction can read simple working drawings, and the third and fourth year apprentices become adept in reading the most difficult drawings. When we consider the comparatively small number of so-called mechanics in the average shop who can read drawings readily, and the necessity for being able to do this, its importance can be realized. Not only this, but the boys are able to make sketches or drawings of shop devices or of parts of the equipment, which it is often advisable to have for record at the local shop, or for transmission to the office of the mechanical engineer. During the past year 2,121 drawings and tracings have been made by apprentices in addition to those made in the regular class work. The boys are thus drilled in New York Central Lines standard practice.

Easier to Obtain Apprentices.—"At several shops it was formerly difficult to obtain a sufficient number of suitable apprentices, but now it is possible to obtain all we require of a much better class of boys as they are assured of being given a thorough training in the trades, which combined with the educational advantages, gives them greater opportunities for advancement than formerly. The men in the shops are in thorough sympathy with the apprentice system; the workmen who have sons taking the apprenticeship course realize that their sons are being given better opportunities than they had themselves.

General Benefits.—"Some of the benefits derived by the associated companies due to apprentice training during the past year, 1908-9, are shown in the annual report prepared by Mr. Gardner, and indicate a substantial growth of the ideas of apprenticeship training and demonstrate the co-operation of subordinate officials in the work. Increased efficiency of the developed workmen and greater output of machine tools handled by them is noted as a direct result of the instruction the apprentices have received in the shops and schoolroom. The boys are used on important work much earlier in their course than is customary with other systems.

Piece Work.—"A unique feature of this plan of apprenticeship is that it is applicable to either a day-work or piece-work method of operation in shops, as it is successful under both systems of working.

Labor Unions.—"It is also worthy of note that there has been no criticism of the apprenticeship system by the labor unions, but quite the opposite, as they have endorsed this plan of training the young men as recruits to the trades.

Loyalty to the Company—"The subject of loyalty to the company and co-operation between departments is one that the instructors should earnestly study and instill thoroughly into the minds of the apprentices. The following extract from the card on this subject issued April 15th, 1909, by W. C. Brown, president, should be especially emphasized:

"In order to secure the most effective results for the company and likewise for every individual in the service, it is of the utmost importance that the entire staff of the New York Central Lines should work together as one harmonious family, and it is the earnest request of the management that this spirit shall prevail in all departments."

SOME RESULTS FROM IMPROVED APPRENTICESHIP METHODS.

Mr. Gardner, the assistant superintendent of apprentices, presented a detailed report of the various machines which apprentices have operated during the past year at the various shops. This includes practically every type of machine used in the locomotive machine and erecting shops, car shops, smith shop, boiler shop and tin shop. The list of jobs upon which some of the boys have been employed at various shops also indicates that they are being used on all classes of work in the locomotive machine and erecting shops, boiler shop, smith shop, foundry, car shops, tin and copper shop, and general repair work in roundhouses.

The following statistics concerning the year's work are of interest:

Number of boys who have attended high schools	83
Number of boys who have attended technical schools	8
Number who have studied in outside evening or correspondence schools	73
Number of graduate apprentices made journeymen	58
Number who left the service voluntarily	77
Number discharged	26
Number who have worked on tests with the mechanical engineer's force. (These include engine indicating, coal tests, dynamometer car tests, etc.)	27
Number of boys who have been given experience in the company's (mechanical engineer's) drafting rooms	16
Number who have been given experience in shop drafting rooms	40
Number who have had experience in round-houses	44

Six boys have worked in a shop foreman's office, three in a shop superintendent's office, one in a storekeeper's office and one in an air brake instruction car.

The following 15 boys have been promoted to permanent positions of responsibility:

W. F. Black, shop instructor of apprentices, Oswego, N. Y.
E. Kennedy, shop instructor of apprentices, Depew, N. Y.
B. Frey, drawing instructor of apprentices, St. Thomas, Ont.
F. E. Cooper, resident material inspector, Pittsburgh, Pa.
H. E. Russell, asst. foreman, car machine shop, Collinwood, O.
J. Busdiecker, asst. foreman, rod and motion gang, Collinwood, Ohio.
Paul Kiefer, shop order foreman, Collinwood, O.
J. H. Collins, in charge of engine house machine shop, Oswego. N. Y.
O. G. Milkey, foreman locomotive jobbers, Elkhart, Ind.
R. Barhydt, draftsman, West Albany, N. Y.
J. Latt, draftsman, Depew, N. Y.
S. Bock, draftsman, Cleveland, O.
F. A. Troxel, draftsman, Cleveland, O.
A. A. Shafer, draftsman, Elkhart, Ind.
F. H. Conners, draftsman, Pittsburgh, Pa.

Apprentice boys who have been used as assistant instructors in the classroom during school hours	32
Number of drawings made by boys which were added to the N. Y. C. Lines files	149
Number of tracings made by boys which were added to the N. Y. C. Lines files	582
Number of drawings added to local drawing room files	578
Tracings added to local drawing room files	812
Total	2121

Note.—(The total reported for 1907-8 was 1344, showing an increase of 777.)

Number of apprentice clubs	3
Number of dances given by apprentice clubs	2
Number of socials given by apprentice clubs	8
Number of individual papers read by apprentices at club meetings	10

Injectors, W. G. Ringland.
The Future of the Apprentice, J. H. Donovan.
Metallic Packing, W. G. Ringland.
The Driver Brake, W. L. Degner.
The Apprentice Club, E. T. Phelan.
Walschaert Valve Gear, J. H. Roden.
Lining Up Guides, W. McGrath.
Balancing Driving Wheels, J. W. Hugill.
Types of Boilers, G. H. Font.
Travels in the Philippines, H. Van Etten.

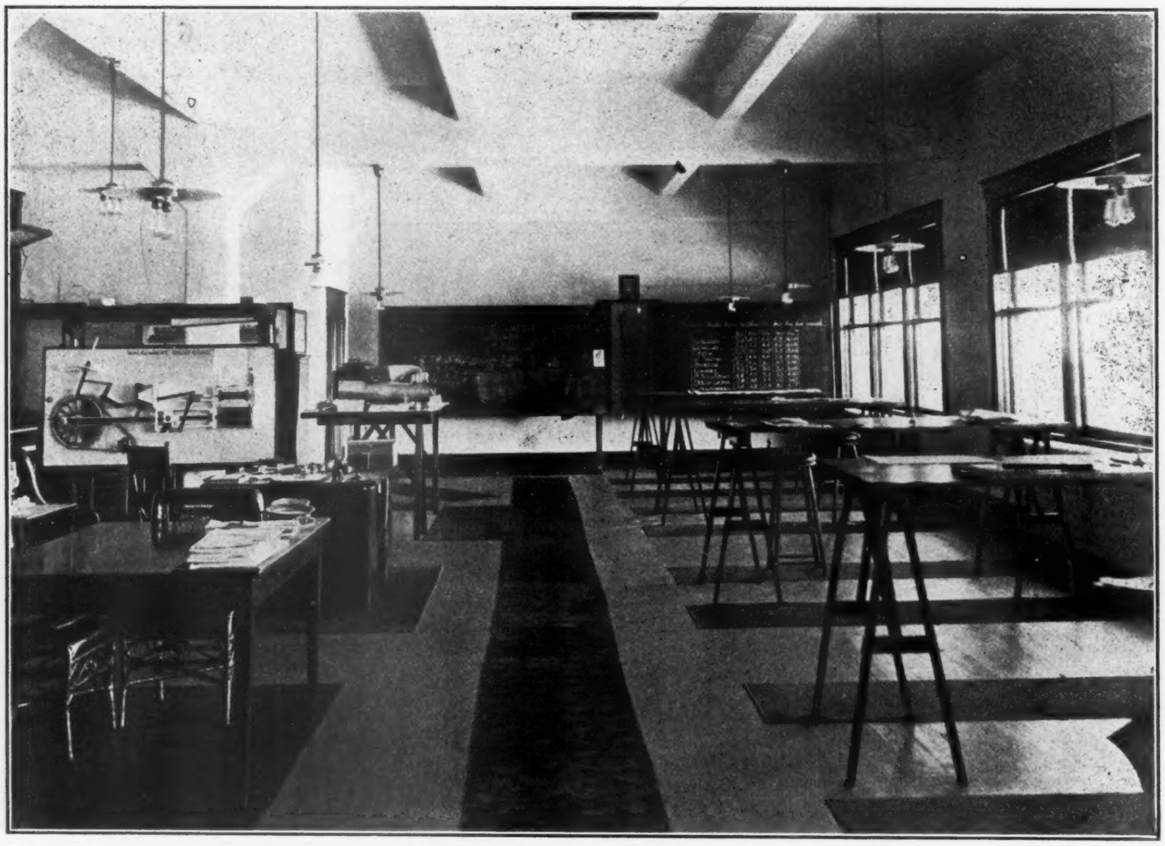
Number of papers read before apprentice clubs by other than apprentices	18

Following are a number of important jobs * done by apprentice boys while working in the shops or roundhouses. Some of these were piece-work and were performed in remarkably short time. All of the work was excellent and worthy of special mention and in many cases the output equaled that of the regular journeyman:

West Albany.—A second year apprentice laid out a locomotive frame for outside equalized brake from blue print. Two second year apprentices laid out a new locomotive boiler for all holes, including boiler mountings, running boards, expansion pads, etc.

Oswego.—A second year apprentice in the tool room is cutting gears, grooving taps and reamers and repairing pneumatic tools. A third year apprentice lays out driving wheel keyways, equalizers and brake rigging from blue print, working piece work. A fourth year apprentice makes cabs, cab doors, sashes, etc., working from blue print.

Depew.—A second year apprentice working in the roundhouse overhauled an air compressor and made a gear rack for large lathes. Two fourth year apprentices are in the tool room making dies and tools, gear cutting, etc. They have built a flue testing machine and a hydraulic press from blue print. A third year apprentice in the millwright gang puts up countershafts and sets machines. A fourth year apprentice acted as foreman in the boiler shop for two weeks during the absence of the regular foreman.



APPRENTICE SCHOOL-ROOM, BEECH GROVE SHOPS—BIG FOUR SYSTEM.

Collinwood.—A third and fourth year apprentice have each set valves in the roundhouse. A third year apprentice has charge of all piston and valve rod packing and grinds all relief valves.

Elkhart.—A second year apprentice with some assistance made a pattern for a 72-inch driving wheel, also for a car truck bolster column with brake hanger bracket. A first year apprentice fitted together 25 cast iron flasks for molding journal boxes. He bolted these up for planing and drilled all holes. He also finished up a set of metal patterns for journal boxes. A second year apprentice bored two cylinders and two piston valve chambers in nine hours, including setting up the machine, working piece work.

St. Thomas.—A fourth year apprentice took charge of the valve setting job during absence of the regular man. A second year apprentice has laid out and put patches on boilers.

Jackson.—A third year apprentice fits pistons, piston valves, crossheads and intercepting valves, working to blue print. A third year apprentice can lay out and plane up a cylinder casting to blue print without assistance.

McKees Rocks.—A second year apprentice squared the frames and lined up cylinders and guides for a new engine, working to blue print. A third year apprentice laid off a reverse lever complete and transmission bar, using blue prints.

Beech Grove.—A third year apprentice laid out holes on a new boiler for gage cocks, gage, water column, fountain, throttle, bell, checks, handrails,

* Editor's Note.—Because of lack of space only a few of the many examples cited by Mr. Gardner are reproduced here.

etc., from blue prints. A first year boy overhauled and repaired a 9½-inch pump, working piece work. A second year boy in the smith shop does eccentric rod and link work, piece work. Has also designed formers for bending clamps and fire door latches. A third year apprentice laid out all the patterns for 13 new boilers, including dome, dome ring, roof sheet, gusset sheet, waist sheet, throat and smoke box sheets, fire door sheet and front and back tube sheets. He also laid out all patterns for two new 8000 gallon tanks; also assembled, riveted and calked one of the new boilers.

Following are listed good responsible jobs * done by apprentice boys while working in the mechanical engineer's office or shop drafting room. This is all excellent work and worthy of special mention:

West Albany.—A second year apprentice made drawings for an 8½-inch improved compound air pump; one is to be built for trial. A third year apprentice made a book of 433 tracings from sketches of parts for smith shop piece work schedule. A fourth year apprentice made tracings for three layouts of machine location in new machine and smith shops.

Oswego.—A third year apprentice designed and made drawings and tracings for link motion for classroom engine. A second year apprentice made drawings and tracings for a 3-inch tube roller, pneumatic cylinder cock, tool post slide, punch and die and hard grease lubricator.

Collinwood.—A fourth year apprentice made 60 drawings and tracings of them for small tools used in the boiler shop. A third year apprentice made a list of all air tools in use, obtaining all information regarding them.

Elkhart.—A third year apprentice has for nine months been designing and making drawings and supervising the installation of pipe clamps for all classes of locomotives. A second year apprentice has been making comparative tests of material applied to 50 locomotives.

St. Thomas.—A first year apprentice made an assembled drawing of a turret head, together with sketches of all the necessary attachments for making patch bolts and later made working drawings of them. A fourth year apprentice designed details for a grate arrangement and a dump rigging for a pile driver boiler.

McKees Rocks.—A third year apprentice made a complete set of sketches, drawings and tracings for valve stem and piston packing. A third year apprentice made sketches of front end arrangement and completed a general drawing of it.

Beech Grove.—A fourth year apprentice made elevation sketches, drawings and tracings for rebuilding a class F-62 locomotive. First and second year apprentices made sketches, drawings and tracings for the cross-sections of above locomotive.

Depew.—A fourth year apprentice scaled down and traced a locomotive boiler complete. A third year apprentice made a drawing of a brush holder for an electric crane.

Jackson.—A third year apprentice made drawings and tracings for the redesigning of a flue rattler; sketches, drawing and tracing of screw press for the shop; complete drawings and details for flue welding furnace; also tracing of elevation and sections for three types of cylinders. Another third year apprentice made drawings and tracing for a pneumatic staybolt breaker.

A NEW DRAWING COURSE FOR CAR SHOP APPRENTICES.

R. M. Brown.—After consultation with heads of departments and mechanics we find a wide variation in regard to which parts of cars are most important for a drawing course for apprentices. We have arranged the following course to be given the car apprentice after he has finished the general drawing course. On the first sheet are seven drawings showing joints, splices and bracing. On the second sheet are shown partial drawings of the following body and framing details: Post pocket, truss rod bearing, ⅞" brace rod washer, sill step, push pole pocket, stake pocket, truss rod anchor, needle beam bearer.

On the third sheet are wood details as follows: Sheathing section, 2½" flooring, ⅞" flooring, sheathing (outside), floor fillet, end sill, vestibule step, crosstie beams.

On sheets 4 and 5 are partial drawings of truck details, taking the six-wheel Pullman truck as a representative type; on sheets 6 and 7 are partial drawings of the draft gear and platform details of a standard passenger coach. The remainder of the course should give practice in drawing steel and wood underframing, floor plans and general drawings. Care should be taken to choose standard cast and wrought iron details which are in use on all the N. Y. C. Lines in order that the models may be easily obtained.

Discussion.—Mr. Brown's suggestions seemed to meet with the approval of the conference.

THE FREIGHT CAR SHOP APPRENTICE.

(Editor's Note: This course is intended largely for young men who have started in in the freight car repair department and who seem to be capable of developing into good inspectors or foremen.)

F. Deyot, Jr.—The schedule for freight car apprentices exclusively should give the apprentice a thorough knowledge of the manufacture and construction of freight car equipment in general. Our present apprenticeship system in this department includes only the machinist, blacksmith, carpenter and tinsmith trades, and since the variety of work required for freight car work in these trades is limited and only a small amount of skill required, we cannot expect to turn out very high class mechanics. However, with models and a proper course of lectures, the apprentice will acquire a fair elementary knowledge of work which he may not be called upon to do in the shop.

The schedule as outlined below would result in more thoroughly educating apprentices who are able to fill a foreman's position than if they had simply worked at any one trade for the entire term:

Blacksmith Shop	6 months
Machine Shop	6 "
Tin Shop	6 "
Planing Mill	6 "
Carpenter Shop	6 "
Erecting Shop	6 "

This schedule allows the boy a year for general car construction work and for work in any departments other than those mentioned above.

STIMULATING HOME WORK.

H. S. Rauch.—This can be done to a certain extent by giving data sheets* as a reward, but we cannot rely on it entirely as it takes the average apprentice about two years before he begins to realize the value of such information. I would suggest as a further stimulus that the average number of problem sheets worked out per capita at each point be sent to the New York office on the first of each month. These averages should then be arranged in bulletin form and sent out to all schools, and be posted on the bulletin board in the classroom. I think all instructors and apprentices would look forward with interest to the arrival of these bulletins.

A. L. Devine.—Since a majority of apprentices consider home work drudgery, it is quite difficult to stimulate it to any great extent without giving the boys some inducement; something attractive which will hold their interest. I believe this can be remedied by giving each apprentice a data sheet with each home problem sheet. We have tried this during the year and found the results very satisfactory; it was appreciated by the boys and caused no extra labor for the instructor as the data sheet prints were made by the apprentices during school hours. No trouble will be experienced in getting good material for at the present writing 28 data sheets have been furnished and 24 more are under way, making a total of 52. It will be an easy matter to increase this number to accommodate the total number of home problem sheets for there are many useful tables and other interesting information which may be adapted to our conditions. I would suggest that an additional binder be furnished each apprentice to file his data sheets. This will be of more value during and after his apprenticeship than the problem sheets and it is impossible to make one binder do for both, especially after a boy has served his second year.

(To be continued next month.)

FLEXIBLE STAYBOLTS.—Let us consider the flexible staybolt at a cost of 50 per cent. more for application to a locomotive boiler. We shopped one of our engines for overhauling. The boiler was sent to the boiler shop for a new firebox, with instructions to make a full installation of flexible staybolts; that is, back head, throat sheet, and both side sheets up to the seams of the wagon top. This engine has been in service now for over two years and has not had one broken staybolt removed. This looks pretty good for the flexible staybolts, as engines of this same type only run from 60 to 90 days before more or less of the solid staybolts have to be renewed.—*C. J. Murray, Erie Railroad, before Int. Master Boiler Makers' Assn.*

* See p. 138, April, 1909, issue of this journal.

SUB-BITUMINOUS OR LIGNITE COAL AS FUEL FOR LOCOMOTIVES.

E. W. Fitt.*

The enormous deposits of sub-bituminous, or as it is more commonly called, lignite, coal in the state of Wyoming and northern parts of Colorado, makes the question of using it as a fuel for locomotives of great importance, not only to these states, but also to the railroad companies whose lines pass through or near the lignite districts. The deposits cover without question one-half the area of Wyoming and probably one-third that of Colorado. In the former state there are some ten or more veins of coal which run from a few inches to forty feet in thickness. The quality of the coal, however, is not uniform, and a different appearing coal will be mined in one hill to that in one not half a mile distant. Many shafts have been sunk, but this method of mining is not entirely satisfactory because of the quantity of water which percolates through the coal, the most successful mines being those driven into the hillside. This coal is very bright and shiny and almost entirely free of impurities; the fracture is sharp and irregular.

In the northern Colorado coal field several veins are recognized which vary in thickness from seven to fourteen feet, and it is not difficult to trace them, chiefly because each variety has a different appearance. The surface of the ground is rolling prairie, some parts being depressed, forming small valleys, where faults exist, which affect somewhat the depth of the coal from the surface. The principal mines operating, are shafts of various depths, ranging from 185 to 254 feet. The coal is bright and shiny, the fracture is regular and in some cases vertical, the layers of stratification being well defined. Some samples from the few mines driven into the hillsides are dull black and fracture is irregular. It is not considered, however, that this latter coal is any better quality than the grades from lower levels. Analysis of the different grades from both states show only slight variations, but experience has shown that a laboratory test does not give sufficient information to determine accurately whether one grade is superior to another, for practical use, and reliance should, therefore, be placed upon service tests made on a locomotive.

The following analyses are the average of many samples from fields in Colorado and Wyoming and are representative of the different mines now in operation in those states. The B. T. U. is calculated and is not to be considered entirely accurate.

State	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	Heat Units B. T. U.
Colorado..........	15.95	32.65	46.29	4.03	0.98	11458
Colorado.	13.08	36.22	45.67	5.01	2.12	12181
Wyoming.........	20.13	33.06	42.39	3.50	0.91	11072
Wyoming.........	9.44	40.47	45.74	3.83	0.54	11564

There are very few impurities in this coal, the percentage of ash and sulphur being small. The percentage of moisture is, of course, very high, some coals having as much as twenty-five per cent. This affects the storage qualities and it is necessary to protect it from the weather if stored at all. When stored under cover and properly protected by floor or platform from the moisture coming from the ground, it will keep in good condition for a long time without slacking to any extent or being in danger of spontaneous combustion. Experiments have shown that coal stored in open cars from one week to ten days loses from 5 to 8 per cent. of its moisture to an average depth of four inches, and will show signs of slacking. Below this depth the coal does not show so great deterioration, the total loss per car load not exceeding 2 per cent. As a general rule, the coal is used within ten days from the mine, when the best results are obtained; under these conditions it has very few equals as a steam producer.

There is a wide difference in the Wyoming coal, the samples analyzed having been taken from the extreme eastern and western fields. It will be noticed that the ash is about the same, and the greatest difference is in moisture and volatile matter, the sample with the least moisture being a very fair storage coal. There is not such a noticeable difference between the Colorado samples, except in the amount of sulphur, and it is considered that the percentage is higher than it would have been if more care had been taken in the selection of samples.

Both these coals are good steam producers, not only for stationary boilers, but also for locomotives, and are now used with success on some of the largest engines in the United States, very few failures occurring from lack of steam, leaking flues or crown stays; in fact, it is preferred to semi-bituminous or bituminous coal by the men using it, especially in bad water districts. The results obtained show it to be an economical fuel, though a slightly larger quantity is used per 100-ton mile than bituminous coal, still, the difference in first cost and maintenance of powei more than covers the cost of increased consumption. It is not so hard on flues, crown stays, staybolts, grates or ashpans as bituminous coal, there being so little ash there is no clinker when properly fired, with practically no shaking of grates.

Notwithstanding these good features, there are some serious objections to its use on locomotives, which may be outlined as follows:

1. Danger of setting fire to property on or near the right of way.

2. The necessity of special spark arresting devices, grates and ashpan.

3. Poor storage qualities.

Objections 1 and 2 are so closely allied, they will be considered under one heading.

Sparks from lignite being light and wood-like, have the peculiarity of remaining alive until almost entirely consumed, in this respect differing from those from bituminous coal. Consequently, greater care has to be taken of the spark arresting devices for lignite coal, and the successful use of this coal on locomotives as at present designed practically depends on three things, namely:

(a). Proper construction of spark arresting devices.

(b). Inspection and maintenance at terminals.

(c). Firing of the locomotive.

By proper construction is meant that in the front end the nettings, or other devices applied to the engine must be as nearly spark-proof as it is possible to make them. It will not do to have any openings around the edges of the netting, especially along the sides or where the steam and exhaust pipes pass through; these places should be covered with tight-fitting strips of sheet iron bolted down, and, if desired, iron cement can be used. but this is not recommended because then an opportunity is given for covering up careless workmanship. The netting used must be the smallest possible mesh consistent with proper drafting of the engine. Doors in the netting should have iron frames, one fastened to the netting of the door and the other to the netting of the front end. Iron should be placed against iron, and fastened with studs and taper split keys; this method ensures a tight joint.

The ashpan is also a very important feature. It requires to be tightly constructed, all air openings must be covered with double

* Consulting Engineer, 516 Bee Building, Omaha, Neb.

netting to prevent escape of sparks and doors should close tight to their frames; these precautions are necessary because high winds will blow the ashes out of the ashpan if it is loosely put together, causing trouble on the right of way.

Inspection and Maintenance.—Too much attention cannot be given this work; on it depends success or failure with regard to throwing fire from the stack or dropping from the ashpan. It is

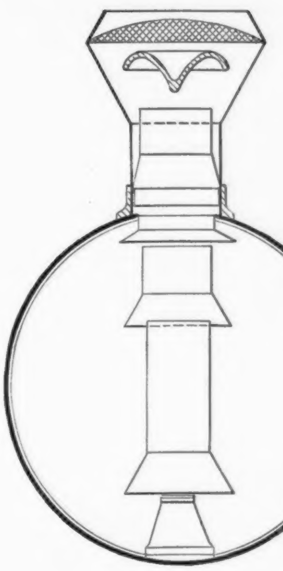


FIG. 1.

possible when careful inspection and prompt repairs are made, to run engines for months without complaint, still, although inspection be carefully made, if repairs are not promptly done, it may happen that there is a good chance of damage to property on the right of way occurring on the next trip, which often amounts to more than the loss of time by holding the engine and cost of repairs.

Firing.—A good fireman can fire this coal without throwing fire from the stack and have plenty of steam, by firing light and often; but the one who throws in fifteen to twenty scoopsful at one fire, generally waits too long between fires, which results in coal burning down, and when next fire is thrown in, the light sparks are stirred up and ejected from the stack. While these may not be large enough to cause any damage, still they make an alarming illumination which frightens the property owners along the road.

3. The poor storage qualities of this coal are a serious drawback in some respects, but the facility with which it can be obtained more than offsets this objection. As before stated, if it is desired to store this coal for any length of time, say six months, it is then absolutely necessary to keep it under cover and protect it from the moisture of the ground. That it can be stored for that length of time under those conditions without serious deterioration has been proved. The coal loses only a slight portion of its moisture, and the volatile gases remain about the same. This shows that when the coal is fresh the larger part of the moisture is mechanically combined, and is, therefore, in better condition to mix with the heated volatile gases than if it were in chemical combination in the coal. However, it may be accepted that up to the present time the situation does not require the storing of the coal, and practice has proved that the fresher it is used the better the results.

When the foregoing arguments are considered there should be no greater liability to cause fires on buildings and other property near railroad right of way, with lignite than with bituminous coal, for the prevention of throwing fire depends almost entirely on the spark arresting devices and the fireman. Thus if the spark arresters are properly constructed, inspected and maintained, and the engine properly fired, the use of lignite coal as locomotive fuel is entirely feasible.

A short description of some of the front-end arrangements which have been used, and are now in use on locomotives on various roads burning this coal are illustrated, and show the extent to which experiments along this line have been carried in efforts to make a perfect spark arrester. The illustrations show only those which have been known to be successful in actual practice and are in service to-day.

DIAMOND STACK.—The diamond stack, with all its faults, is the oldest and safest spark arrester in service to-day. Though more expensive to maintain and more costly in the consumption of fuel than the straight stack with extended front end, it is without doubt, the most effective. Figure 1 illustrates an ordinary type of diamond stack used on some roads in preference to the extended front end, especially in timber country. Several years ago experiments were made to determine the comparative loss from back pressure between the diamond stack with cone and netting, and the straight stack with extended front and spark arrester, which resulted in showing a loss of over 20 per cent., due to the back pressure in the diamond stack. These experiments showed that the diamond stack was not an economical factor, and efforts were directed to perfecting a straight stack and extended front end that would be a spark arrester and at the same time make a good steaming engine, without increasing the consumption of fuel. It is not the intention to follow up the various designs which were tried and found wanting, and three designs are shown which illustrate different practice and ideas.

EXTENSION FRONT END.—Figures 2, 3 and 4 show the most successful arrangements in service. The first design has been

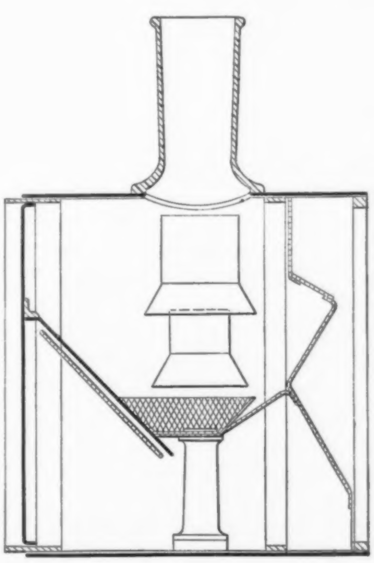


FIG. 2.

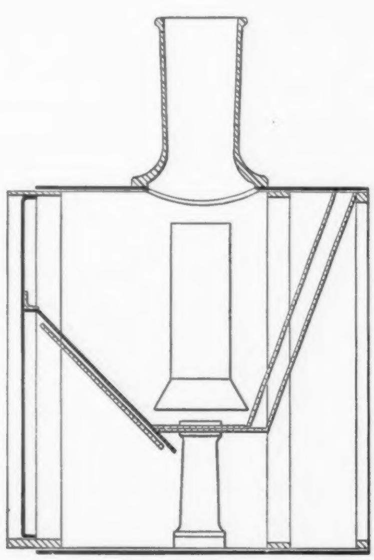


FIG. 3.

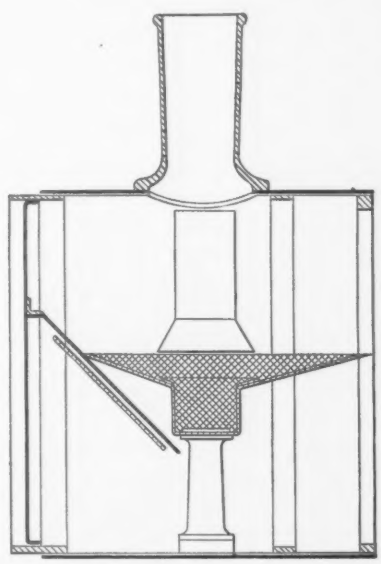


FIG. 4.

very successful as a spark arrester, but some trouble was experienced from filling up and consequent burning out of the lower nettings. This occurred more frequently on the small engines than on the larger ones, and was overcome by substituting a plate for the lower course of netting. The main feature in this plan is the double nettings, the sparks having to pass through two courses before reaching the stack. The repairs with this design are not excessive.

The design shown in Fig. 3 has not been very extensively used, but is far less complicated and uses a larger nozzle tip than Fig. 2. It is practically a self-cleaning front end, depending on the pulverizing of the sparks before they pass through both nettings to the stack. The repairs are light. Objections have been raised to this plan on account of the double doors in the netting, to get at the exhaust tip, which leaves a loop-hole for carelessness in making repairs.

The design shown in Fig. 4 is extensively used on several roads and gives very good satisfaction. It is simpler in construction than either of the others, but has the objection that there is only one course of netting used. This compels the application of a much finer mesh netting than that used in the other types, neither can so large an exhaust tip be used. More sparks are retained in the front end and have frequently to be let out through the cinder hopper, the netting stops up and decreases the draft, and together with the smaller exhaust causes increased consumption of fuel; therefore, notwithstanding the cheaper construction and repairs, it is not as favorably looked on for general economy as Fig. 2, which is considered the most effective of the three designs.

In connection with this subject it might be stated that with all these extended front end plans, it has been found necessary to use an extremely long fire brick arch, which assists in retaining the lighter parts of the coal in the fire box and also helps materially in consuming the volatile gases and excess carbon which otherwise pass off as smoke. The fire-brick arch is built up solid against the flue sheet, thus preventing any direct draft through the flues and protecting them from cold air.

The most suitable ashpan for lignite coal is of the hopper type, with openings at the sides for air. These openings require to be well protected with double netting. The doors require to be made with a tight joint and the levers must be arranged so they can't possibly become unlatched on the road.

Lignite coal breaks up so very easily in the fire box that ordinary grates cannot be used, but special designs with $^9/_{16}$-inch openings between the bars have proved successful. The fingers are short, as it was found that long-fingered grates broke up the fire too much when shaken. Box grates with bars ½-inch wide with $^9/_{16}$-inch openings work quite satisfactorily.

Lignite coal is most efficient on long-flued engines of large boiler capacity, in fact any large consolidation or prairie type engine of modern design will give perfect satisfaction with this coal. It is not necessary to provide for such an extremely large grate surface as the quality of the fuel would lead one to suppose, fifty to fifty-four square feet being ample for a seventy-eight to an eighty-four inch boiler, and is within the limit of endurance of the fireman.

It seems, however, that the proper solution of the problem would be to build a boiler after a new design that would not require special spark arresting devices, and which would have a large heating surface, long flues and grate area in proportion.

Broadening the Viewpoint of an Official.—As a further means of education, division officials are sent, a few at a time and usually in a business car, on a fifteen-day trip once a year over other railways to observe methods and appliances. The semi-annual meetings of general officials are held in different cities on the Associated Lines in order that the participants may gain an idea of conditions on all parts of the system. The Chicago office endeavors to spread among all the properties or to cause them to send to each other from every available source all possible information that may have an educational value.—*J. Kruttschnitt before the New York Railroad Club.*

A GOOD OPPORTUNITY FOR AMBITIOUS MEN.

What is designated as an educational bureau of information was established on the Union Pacific Railroad, September 1st. The objects of this bureau, as stated in the circular making the preliminary announcement, are to assist employes to assume greater responsibilities, to increase the knowledge and efficiency of employes, and to prepare prospective employes for the service. It is the policy of the road to, as far possible, fit its own employes for promotion, and the new bureau is intended to assist such of the employes as indicate a desire, to qualify, by means of courses of instruction, which will be specially prepared for them, in addition to the reading and study of such published works as bear in a practical manner on their work.

The privilege of using this bureau is open to all departments and employes free of any charge, the company maintaining it for the benefit of the entire service. The work of the bureau will be controlled by a board of supervisors, consisting of the following officers of the company: Vice-president and general manager, freight traffic manager, general superintendent, chief engineer, superintendent motive power and machinery.

An advisory board, consisting of responsible officials selected from the various departments, (*i. e.*, operating, traffic, engineering, mechanical, signal, legal, auditing, etc.), will act with the chief of the bureau in handling all questions relating to their respective departments. This board passes on all applications for courses and assigns such work as it deems best suited to the man. It also passes on the answers to all questions sent in, so that there will be no danger of interference with the general organization's instructions or ideas.

The following outline of the work of the new department is taken from one of the circulars issued from the office of the general superintendent.

"*Assisting Employes to Assume Greater Responsibilities.*—The bureau will offer any employe desiring to qualify himself to assume greater responsibilities, a course of reading and study along the line which he may indicate. This course will be conducted somewhat on the method of now existing correspondence schools, and will be prepared with special reference to the needs of the particular case. This course need not necessarily be confined to the particular work of the department with which the employe is connected, but may embrace any subject, the knowledge of which may be of value to the employe in the position now occupied or which would help to qualify the employe to change positions to a line of work which would be more nearly suited to his ambition or desire.

"An employe taking up a special line of work of this kind must show his interest in it by doing a reasonable amount of reading or studying. Otherwise the company will not be justified in continuing the expense of maintaining the employe on its student rolls.

"Those selected for advancement to minor official positions will be afforded an opportunity, before formal appointment is made, of acquiring a knowledge of the practical workings of such departments as they have not been intimately connected with, through a temporary connection therewith under the direction of the heads of such departments, and at a salary fixed by the board of supervisors.

"*Increasing the Knowledge and Efficiency of Employes Now in the Service.*—This bureau offers to all employes the opportunity to increase their knowledge, thereby increasing their efficiency, by means of the information department feature. Employes desiring information on any problem or proposition connected with their work, or on railroad matters in general, can, without any formality, address this bureau, stating the information desired. Name and address, position or occupation, division, district, office or shop where employed should also be stated. This information will be furnished promptly and in as simple and practical a manner as possible.

"All inquiries should be addressed to the Chief of the Bureau of Information, but any inquiry requiring special departmental information will be referred to the member of the advisory board

best qualified to give the information desired, it being the intention to have all inquiries answered in such a manner that they will in nowise conflict with the instructions, ideas or precedents of the department to which they relate. Questions referred to members of the advisory board will not carry the names of the employes desiring the information, although a record will be kept available to the heads of departments wishing to know whom of their employes are seeking to increase their knowledge of railroad matters.

"It is the intention to further this work by means of lectures on live railway subjects, to be given from time to time at various district headquarters. Pamphlets and reports will be distributed periodically, containing information on subjects of interest. Classes will be organized at various points to teach important subjects, and a representative of this bureau will be continually on the road to handle matters which cannot be properly explained or demonstrated by correspondence.

"Preparing Prospective Employes for the Service.—This bureau will be glad to register the names of dependents or relatives of employes who wish to enter the service of the company, and will also keep in touch with various universities, colleges, high schools and technical schools for the purpose of having at all times material on hand to supply help desired by any of the departments. Persons registering with this bureau may indicate the particular line of work which they desire to follow. They will be given every opportunity for learning the elementary methods and requirements of the department they wish to enter, and while it is not promised that positions will be given to all applicants, it is, however, expected that the various departments will avail themselves of this opportunity for filling vacancies in their ranks from individuals registered with this bureau, who have taken advantage of the opportunity to qualify themselves for the positions desired."

From the last paragraph, quoted above, it would appear that young men about to enter the railroad service will have exceptional opportunities offered to them for gaining a thorough and complete knowledge of the branch of work which they wish to take up.

The headquarters of the bureau is at the Pacific Express Building, Omaha, Neb. D. C. Buell, who, in addition to his railroad training, has had considerable experience in educational work along correspondence lines, has been appointed chief of the bureau; his assistant is G. W. Seiver.

TEMPERING HIGH-SPEED STEEL TOOLS.—The following data as to tempering tools are accurate for practically all makes of good high-speed steel, and cover in a general way the range of these tools. The temper of high-speed tools is in general drawn (when they are tempered at all) somewhat farther than is done with carbon-steel tools. Roughing lathe tools, and all tools for heavy rough cutting, are left untempered. Large reamers and drills with heavy stocks are drawn at 440° F., which is equivalent to a light straw surface color. Ordinary drills, small reamers, and other tools having rather light stocks or bodies, and subject to considerable torsional strains, are drawn at 460° F., or a full straw color. Threading dies and taps, 490° F., very dark straw or brown yellow. Ordinary milling cutters and the like, 400° F., or faint yellow. Punches, stamping or cutting dies, and shear blades, 530° F., purple. Chisels, snaps, and like tools subjected to sudden shocks, 570° F., or polish blue. Wood-working tools of nearly all sorts, 525° to 625° F., which is from light purple to greenish blue, according to shape and kind of wood to be cut. Brassworking should be drawn from 20° to 30° lower than iron or steel cutting tools of the same kind.—*O. M. Becker in the American Machinist.*

FLUX FOR OXY-ACETYLENE WELDING.—After numerous experiments F. C. Sanborn, of Bridgeport, Conn., has discovered that common salt is as good a flux as any of the more expensive compounds.—*American Machinist.*

THE USE OF TWO AIR PUMPS ON THE LOCOMOTIVE.

The advisability of using two medium size air pumps on a locomotive, in place of one large one, was discussed in a committee report at the General Foremen's Convention as follows:

"In applying one air pump to a locomotive there is always a liability of its breaking down at a very unexpected time. With the application of two pumps it is assumed that we must always have one for service in case the other breaks down.

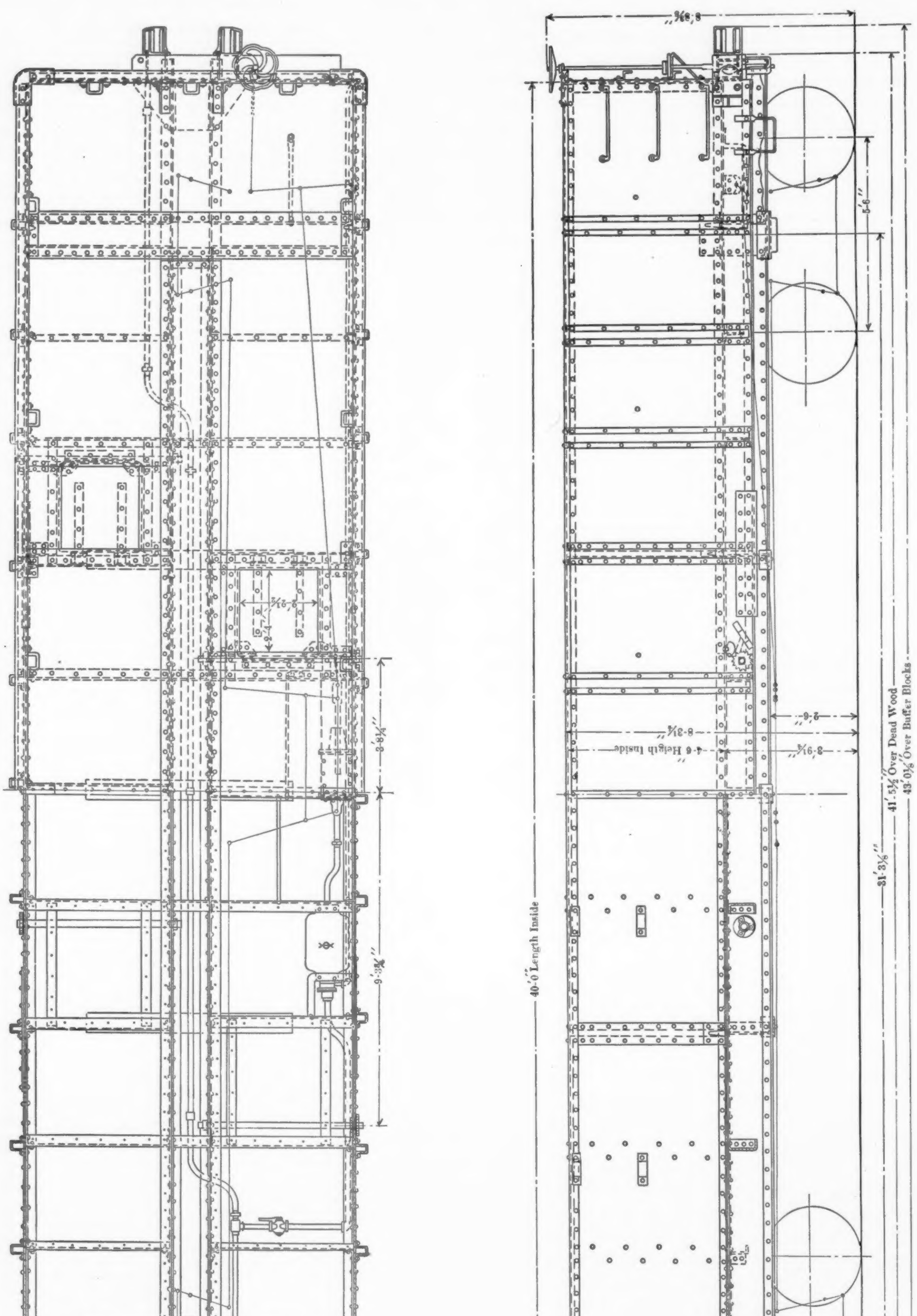
"While the double unit proposition has some very desirable features, we should not overlook the fact that its adoption will, if extra precautions are not taken, lead us into some very undesirable conditions. Therefore, while we are considering the merits of this arrangement as a source of air supply, we should also consider it from a train-handling standpoint. That the number of delays at terminals, so common on account of the inability of the single pump to pump sufficient pressure to properly test the brakes and insure the safe handling of the train, and that the number of air pump failures and slid flat wheels will be materially reduced, can not be questioned. And by reason of the fact that as high temperatures will not be developed during compression with this arrangement as with the single unit, we can expect less trouble with frozen brake pipes. However, it is likely to encourage carelessness on the part of the trainmen and car inspectors in looking after brake pipe leakage, which must be kept within certain limits if we are to expect smooth handling of long trains and to keep the maintenance of freight equipment within a reasonable figure; an excessive brake pipe leakage takes the control of the brakes out of the hands of the engineer, and incites undesired quick action of the brakes, both of which are sure to result in much train parting and damage to equipment and lading.

"At present most of the large freight engines and a number of passenger engines are equipped with 11-inch pumps, these pumps having sufficient capacity to supply most of the big trains when in good condition; in applying two pumps, it would be unnecessary to go to the expense of putting on two 11-inch ones. The following data have been secured from the Big Four, which has three engines in service, with two 9½-inch pumps each, one of which has been in the heaviest freight service for the last year, making 145 miles daily; the present condition of these pumps indicates that they will continue to give satisfactory service for several months.

"Up to the present time the maintenance cost on the two pumps has been less than $1.00, and should it become necessary at the end of 18 months to remove the pumps, they can be overhauled for about $30.00 ($15.00 each), which means a yearly cost of $20.00 for both pumps.

"The average life of the 11-inch pump in heavy freight service is from five to seven months, and the average maintenance cost is about $32.00 a pump per year. The maximum capacity of the 11-inch pump, pumping against 100 pounds pressure, with 200 pounds steam, is about 57 cubic feet of free air per minute. Under the same conditions two 9½-inch pumps will pump 70 cubic feet per minute. The steam consumption per cubic foot of air pumped is practically the same in both cases. The location of the two pumps is only a matter of choice, but it is more desirable and economical in every way to apply both pumps with one bracket on the left side of the shell of the boiler."

INSPECTION OF COAL.—As far as possible, the inspection of coal by purchasers should be made at the mine, in order to know the conditions existing when the coal is loaded. The top of a car can easily be picked carefully, and especially when drop-bottom cars are used it would be difficult to detect the impurities contained below the surface. Sizes used for locomotive purposes cannot always be disposed of commercially, and rejections at points far distant from the mines may work a serious hardship on the producer and the railroad as well.—*From Committee Report before Int. Ry. Fuel Assn.*



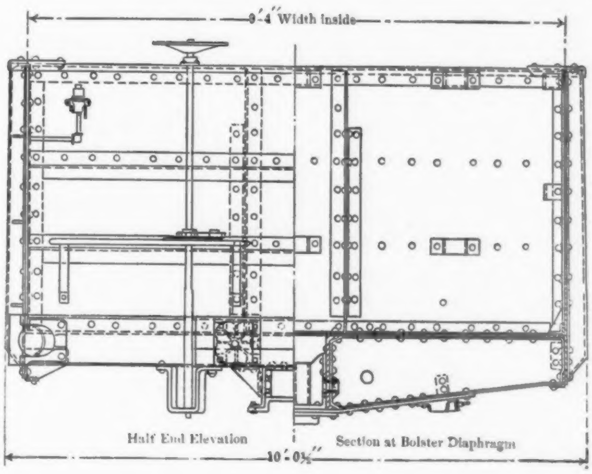
FIFTY-TON STEEL GONDOLA CAR—VIRGINIAN RAILWAY.

FIFTY-TON STEEL GONDOLA CAR.

VIRGINIAN RAILWAY COMPANY.

The Virginian Railway Company has recently received an order of 1,500 all-steel gondola cars from the Pressed Steel Car Company. These cars are 40 feet long inside and have four small drop doors. Practically all of the coal cars on this road are unloaded by machine; it is therefore not necessary to arrange them for self-unloading and only enough drop doors are provided to facilitate the unloading through the bottom at points where the unloaders are not in use, or in case other classes of material are transported.

In order to keep down the stock of material for car repairs and to reduce the cost of making repairs all pressed steel members and plates are designed to be used interchangeably on all designs of freight cars, cabooses and tender frames.

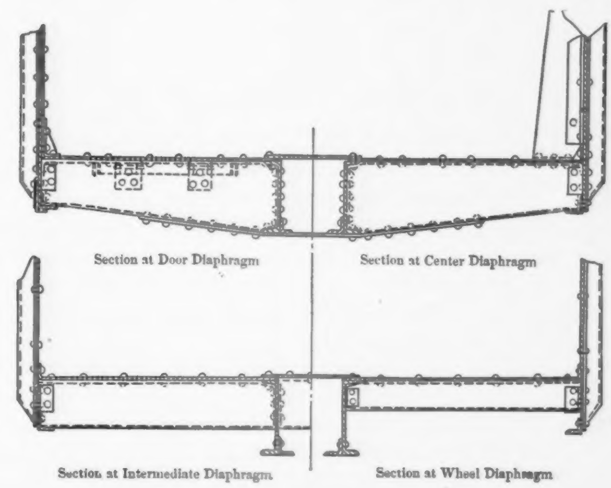


The general dimensions of these cars are as follows:

Length inside	40 ft.
Length over buffer blocks	43 ft. ⅛ in.
Width inside	9 ft. 4 in.
Width over side stakes	10 ft. ½ in.
Height inside	4 ft. 6 in.
Height from rail to top of sides	8 ft. 3¼ in.
Center to center of trucks	31 ft. 3⅛ in.
Number of drop doors	4
Size of drop doors	2 ft. 4 in. by 2 ft. 2½ in.
Weight of car	43,300 lbs.

The center sills are 15 in., 40 lb., channels. They are covered between the bolsters with a 5/16 in. cover plate 20 in. wide and tied together by the top cover plate 7/16 in. thick, 16 in. wide, extending practically the full width of the car and with a bottom cover plate ½ in. thick, 16 in. wide, extending beyond the side bearings. The ¼ in. floor plate at the end of the car is in one piece and its rear end is riveted between the bolster cover plate and the diaphragms. The floor plates, between the bolsters, are ¼ in. thick and are bent upwards at the sides and riveted to the side sheets as shown.

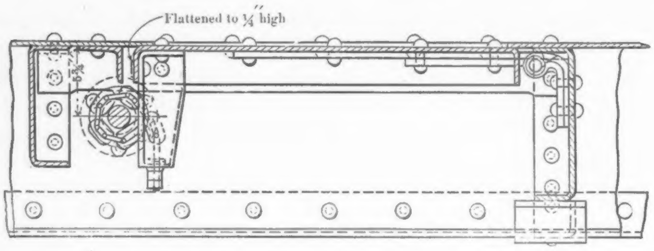
There are four drop doors with openings 2 ft. 4 in. long and 2 ft. 2½ in. wide. These doors are operated by a simple mechanism—a chain winding on a shaft—as shown in one of the illustrations. At the center of the car the center sills and sides are tied together by pressed steel diaphragms, similar to those used in the bolsters, and with a plate 6 in. wide extending across the bottom about two-thirds the width of the car. Between each pair of doors a similar construction is used. On the other side of the doors are what are known as intermediate diaphragms. These consist of a pressed steel diaphragm between the center sills, as well as between the center sills and the sides; these diaphragms are of a uniform depth of 9-11/16 in. The cross tie between the intermediate tie and the bolster is an 8 in. channel, a greater depth not being allowable because of its being over the



are reinforced at the bottom, on the inside between the bolsters, with 3 x 3½ x 5/16 in. angles. Westinghouse friction draft gear is used with Farlow attachments. The bolster consists of pressed steel diaphragms between the center sills and the sides and a steel casting between the center sills. These parts are securely wheels. These channels only extend between the center sills and the sides, the center sills not being tied at these points.

The sides and ends of the car are constructed of ¼ in. plate. The sides are stiffened at intervals, varying from 2 ft. 10½ in. to about 3 ft. 11 in., by U-shaped pressed steel side stakes, 4 in.

deep at the point of greatest depth. The side sheet is reinforced at the bottom on the inside by 3½ x 3 x 5/16 in. angles and at the top on the outside by 4 x 3½ x ½ in. bulb angles. The ends of the car are stiffened on the outside by two 5 in. Z bars placed horizontally and by two vertical gusset plates on the inside just over the center sills. They are also reinforced at the top by bulb angles, in the same manner as the sides. The buffers are



CROSS SECTION THROUGH DROP DOOR.

bolted to wooden buffing blocks reinforced at the back by a channel.

The trucks are of the diamond arch bar type with pressed steel bolsters. The general design of these cars was prepared under the direction of R. P. C. Sanderson, superintendent of motive power, the details being worked out by the Pressed Steel Car Company.

INCREASING THE LIFE OF LOCOMOTIVE CRANK AXLES.

The extensive adoption of 4-cylinder 4-crank locomotives in France has shown the necessity of improving the design of the crank axles. Their cost is very high, and cracks in the webs or cheeks began to appear after a relatively short period of service. Under these conditions, the railway engineers have been compelled to investigate the best design of crank axle in order to increase its life and to reduce the maintenance expenses of the locomotives. On the Western Railway of France the following observations have been made on crank axles of the oblique type (as shown in Fig. 1) used on fast passenger engines:—

(1) Of 13 ordinary axles of annealed open-hearth steel on locomotives of the 4-4-0 class, 10 were found to have cracks after runs of from 105,000 to 158,000 miles; (2) of 26 hollow axles from similar locomotives, three were found to have cracks after making runs of from 291,400 to 339,760 miles; (3) other things being equal, the crank axles of engines of the 4-4-2 class gave less service than those on engines of the 4-4-0 class, and on the former engines axles of annealed open-hearth steel have developed cracks after runs of from 45,880 to 124,000 miles.

The axles crack always in the filleted angles A or B, Fig. 1, under the influences of the violent shocks in service, the dynamic

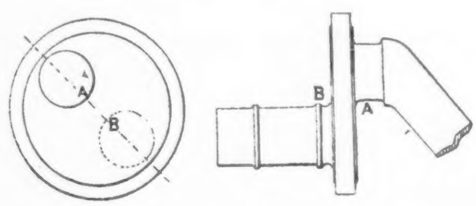


FIG. 1.

effects of the shocks being concentrated at these points, where they cannot be absorbed by the elasticity of the metal. Permanent deformation is set up, and in time a crack appears; its development is often facilitated by defects in the metal, resulting from the segregation of metal in the ingot.

In order to avoid the formation of these cracks, Mr. Frémont, Chief of Works at the School of Mines, has devised the plan of cutting away the crank web in the part between the journal and the crank pin, as shown in Fig. 2. With this arrangement, the dynamic effects are not concentrated at a point, but are distributed around C and D, over the largest possible amount of metal, and the elasticity of which can absorb them. This method also removes the defective metal that may occur in the axis of the ingot. Fig. 2 shows the arrangement for double-web cranks on straight axles, as well as for single-web cranks on bent or oblique axles.

Five axles of the oblique type, which showed cracks after runs of 106,480 to 213,195 miles (on engines of the 4-4-0 class) had the webs slotted out in the Frémont plan so as to remove all

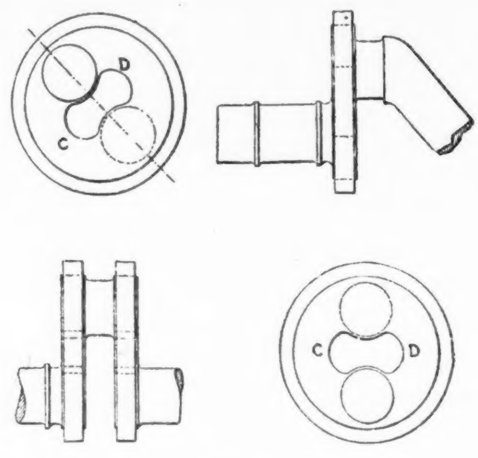


FIG. 2.

traces of the cracks. Since then (and up to October, 1908) they had run for from 29,080 to 92,253 miles, and had shown no signs of cracks.

Four new crank axles with slotted webs were put in service on engines of the 4-4-2 class (with which cracks are most likely to occur), and have run from 81,230 to 110,193 miles without showing any cracks. Axles made of the same metal, but with solid webs, were applied at the same time to similar engines in the same service; these showed cracks after running less than 62,000 miles.—*E. Hallard, Asst. M. E. Southern Ry. of France in the Revue Generale des Chemins de Fer.*

TESTING LOCOMOTIVE FUEL.

A committee of the International Railway Fuel Association recommended in its report that fuel contracts should be based on a stipulated amount of ash, with penalties for excess and premiums for reductions, as is the practice of the United States Government. While the members generally seemed to favor this principle, there is more or less uncertainty as to just how the ash content should be determined.

R. Emerson, of the Lehigh Valley, in speaking on this phase of the question, said: "The farther my experience has extended in these matters, the less confidence I have in the methods of sampling fuel. Suppose a consumer receives a carload of coal and wishes to determine roughly the average per cent. of ash in that carload. He attempts to pick a sample. Let him pick two or three pieces of coal at one end of the car, two or three pieces of coal at the other end of the car, two or three at the middle; he gathers up a few impurities that he sees lying around, bone or slate. The quality may fluctuate through the car, and he takes more samples, finally getting quite a little pile of coal. He then quarters it, dividing it into four parts so as to get what he calls an average sample. He breaks the lumps up more, quarters that again and finally when he gets done with all, he has a very small pulverized sample that is supposed to be an average sample of the fuel. He contents himself with not only one sample, but he may take a dozen of such supposedly average samples and then proceed to analyze his fuel in the laboratory to determine its calorific value, and its chemical constituents. Now he takes all his results and averages them together and gets (to his satisfaction at least) the average determination of the quality of the coal furnished by that car.

"But it seems to me that, notwithstanding the care of his

method of analyzing and his mathematical averages, his first selection of a sample is unscientific and crude in the extreme. It is a question in my mind if, owing to the crudeness of selecting the sample, however conscientious a man may be, however many witnesses he may have representing the mine or somebody else, to see that the sample is a fair one, that you are not getting good results which you know really represent the calorific content of the car. Mr. Crawford, of the Burlington Lines, has gone rather to the method of testing the fuel in actual service on the locomotives, and that method, while a more rough-and-ready one, it seems to me is really much more nearly in the right direction. (See AMERICAN ENGINEER, April, 1908, page 124.)

"On the Lehigh Valley, we have not gone into this question of regularly testing the quality of the coal received. I have been asked to take that matter up and do something in connection with it, but I have been so dissatisfied with the ordinary "scientific" method that I have not been willing to put our company to that expense. Mr. Crawford's results have been more satisfactory, and I have been seriously considering using his method.

"There has lately occurred to me, however, the possibility of using a much more wholesale and perhaps generally more practical and satisfactory method, and that would be to weigh the ash from each locomotive, just the same as we weigh the coal issued to each locomotive. Of course, there will be certain difficulties in connection with that. The ashes will often be scattered and dropped along the line, fires will be cleaned at odd stations and a certain amount of the ash content will be lost in that way, but perhaps, taking certain runs, you might get at some fairly satisfactory result by weighing all of the ashes that were produced from all the coal issued to those locomotives, and in that way arrive roughly at a per cent. of ash content of the coal that was consumed, and determine the basis on which you would pay your mine for the quality of coal delivered."

Geo. M. Carpenter, of the N. C. & St. L., agreed with Mr. Emerson, and spoke as follows: "The usual custom is for the party who is to make the analysis to go to the face of the vein and make a series of clippings from the top or roof, taking anything that may come in the path and take a sample, perhaps, two or three times on the same face; take it then into his laboratory, and then he will come out, and tell you of the high per cent. of carbon that this coal shows, the low per cent. of sulphur, ash and volatile matter. While he is doing that, some miner drills a hole into that same vein and makes a shot, and if that same man were to come back and take another sample and analyze it, his results would be altogether different. There are very few mines in this country that the analysis will prevail or follow itself up throughout the entire vein. The consequence is that buying coal on the fuel analysis of the fixed carbon in the coal, has never yet been found to be uniform or satisfactory. I agree with Mr. Emerson when he says that to determine the most economical grade of coal is to put it into service and get its value from a practical standpoint, and not a theoretical one."

Eugene McAuliffe, president of the association, at the close of the discussion said:

"I appreciate that laboratory work is scientific and generally accurate, but Mr. Emerson struck the keynote when he said it all rested with the fellow that took the sample. * * * I believe that the B. T. U. discussion which has been exploited a great deal in the last four or five years is rather on the wane. I do not believe that it is practical to apply it to railroads at all. In the first place, you have to measure up the results you get from railroad coal after it is placed on the engine tender, and you know sometimes we take an operator's coal and keep it on hand a couple of months before putting it on the engine tender, and the result is, you have to take your sample off the coal chute, and we have not the facilities at the average coaling station to take samples and to get, as Mr. Emerson says, a thoroughly representative sample. I would say, for a fair sample, I would want two or three tons of coal to mix, reduce, quarter, grind, and work down; it would probably increase the supervision incident to the purchase, handling, distribution and economical use of coal four or five per cent. How clearly out of the question it would be to get the force necessary to properly sample railroad coal and get reasonably accurate results on the B. T. U. basis!

"I think there is only one way to determine the relative efficiency of coal. In the first place, I believe a coal that will get a heavy train over the road in a reasonable time with a reasonable quantity of fuel is probably the most economical coal for a railroad to buy. If you can do that with mine run, I say, buy mine run; if you cannot do it with mine run, buy screened coal. If you can get a successful grade of coal by screening out a percentage of the slack, buy that. If you have to have it all taken out, have it taken out and pay for it. There is only one way to test locomotive coal, and that is to take an engine of average character and condition, with an average crew—I am speaking of an average crew from the standpoint of intelligence and experience—and give them a full tonnage train that will keep the engine busy over the division, put competent, honest observers on the engine, and, after weighing the coal and calibrating the tank, determine the exact amount of coal and water used, compute at the end of probably a three round-trip period the evaporative efficiency of the coal; make note of weather conditions, delays, time used in cleaning fires, ash pans, etc., and keep that work up. It should be kept up for about six months during the summer season. I do not believe in conducting evaporative tests, or locomotive tests in the winter time, when the weather conditions are so shifting as to practically nullify the results. The losses from radiation are abnormal in cold weather, therefore we should have an average temperature. I do not think the man in charge of the tests should work on one grade of coal an undue length of time—they become careless—but shift the thing around, keep moving, and at the end of a couple of years you will know fairly well where you are at.

AVAILABLE WATER POWER.—M. O. Leighton, of the United States Geological Survey, estimates that "were all practicable storage sites utilized and the water properly applied, there might be established eventually in the country a total power installation of at least 200,000,000 horse-power and probably much more." The significance of this is more readily apparent when it is recalled that the total estimated horse-power now used in this country, including the railroads, is only about 30,000,000. Thus far only about 5,356,000 h.p. of water power has been developed. The United States Geological Survey has recently issued a bulletin designated as "Water-Supply Paper 234," containing a number of papers on conservation of water resources which were presented before the National Conservation Commission. Among these are "Distribution of Rainfall," by Henry Gannett; "Floods," by M. O. Leighton; "Developed Water Powers," compiled under the direction of W. M. Stewart, with discussion by M. O. Leighton; "Undeveloped Water Powers," by M. O. Leighton; "Irrigation," by F. H. Newell; "Underground Waters," by W. C. Mendenhall; "Denudation," by R. B. Dole and H. Stabler, and "Control of Catchment Areas," by H. N. Parker.

THE VALUE OF GOOD LIGHTING.—As a mere matter of industrial economy, there is no item of such importance as the efficiency of workmen and workwomen. The "cost of raw materials," "interest and depreciation," "office expense," or any item that you will, is wholly overshadowed by the cost of labor; and there is no single utility that has a greater influence upon the actual efficiency of the laborer than the light by which he works. At least 99 per cent. of the results of labor are accomplished under the direction of the sense of vision. Imperfect or defective vision makes labor difficult, and the results imperfect. Of all things let the workman have a good light. As human labor has become less a matter of mere physical strength, and more a matter of intelligence, the mental attitude of the worker has come to be of greater importance. The discontented worker will never equal in efficiency the contented worker, and the worker who is compelled to use poor tools, the most important of which is light, is bound to be discontented.—*E. L. Elliott in the Illuminating Engineer.*

LOCOMOTIVE COUNTERBALANCING.*

H. H. VAUGHAN.

The counterbalancing of locomotive engines is one of the few problems in connection with that apparently simple yet exceedingly complex machine, which is capable of an exact theoretical determination. When the weights, locations and movements of the various parts of an engine are known, it is possible to calculate accurately the forces which they cause at any speed of rotation, and apart from some practical considerations, such as the engine being constricted in its lateral movements by the wheels which support and guide it on the rails, and the fact that it is connected in a more or less imperfect way with a tender, the movements which result from the action of these forces can also be exactly ascertained; this subject has consequently been very thoroughly treated by a number of writers, and I shall therefore endeavor to discuss, as shortly as possible, the theoretical principles which underlie it.

The disturbing forces which necessitate the counterbalancing of any reciprocating engine are those required to start and stop the mass of the reciprocating parts at each end of the stroke;

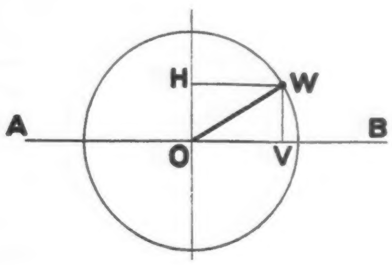


FIG. 1.

neglecting the disturbance caused by the obliquity of the connecting rod, which is unnecessary to consider in any existing type of locomotive, these forces are identical with that caused by a corresponding mass at the crank pin, with the exception that they have no vertical effect.

In Fig. 1 let the weight W be rotating around the center O, at a velocity of V feet per second; then what is known as the centrifugal force, which is really the force that is required to make W move in a curved line instead of in a straight line, as it would do if left to itself, acts along the line W O, and equals $\frac{W V^2}{32.2r}$ when r is the radius in feet.

This force W O can be resolved into two components W H and W V, the first acting entirely in a horizontal, and the other in a vertical direction; it will be seen that when W is on the vertical diameter W H is nothing, while W V equals W O, and when it is on the horizontal diameter W H equals W O while W V is nothing. Now, if the weight W moved backwards and forwards along the horizontal line A B in such a way that its position on that line was always vertically under or over the position of W when rotating uniformly around the center O, the force necessary to accelerate or retard it is always W H, or, in other words, equals the horizontal component of the centrifugal force due to an equal weight rotating in a circle.

This is what happens in the case of a weight such as a piston and crosshead actuated in a horizontal line by a connecting rod, as in Fig. 2; here the distance of the weight P from the center of the stroke corresponds with the horizontal distance of the crank pin C from the center O, and the force accelerating or retarding it is equal to C H when C O equals the centrifugal force which P would exert if moving on the path of C.

Since P in this case is moving entirely in a horizontal plane, it gives rise to no vertical forces whatever, and it is this fact that introduces all the difficulties in connection with balancing an engine; before, however, discussing that question, the connecting rod must be referred to. It is evident that this has at one end a circular, and at the other a reciprocating movement, while between the ends, the motion of any part is of an intermediate nature; the result is the same as though part of its weight were concentrated at the crank pins and had a circular motion, while the remainder was concentrated at the crosshead and had reciprocating motion.

In a paper read before the Northwest Railway Club, in 1893, I suggested that four-fifths of the weight of the back end should be taken at the crank pin, and the weight of the front end and one-fifth of the back end at the cross-head, figures that were obtained by calculations from two or three types of rod; this question was, however, treated in an exceedingly ingenious and scientific way in a paper read before the New York Railway Club by R. A. Parke. He developed an accurate method for obtaining the exact division of weights for any rod, and his results showed for modern types of rod that five-sixths of the weight of the back end of the rod should be considered as concentrated at the crank pin with reasonable accuracy. I would refer anyone interested in this subject to his paper, as it is a most interesting example of the application of a really difficult methematical analysis, by which an absolutely simple method is deduced for obtaining correct results. I consider, however, for practical purposes, that five-sixths of the weight of the back end is sufficiently accurate, and that figure is used on the Canadian Pacific.

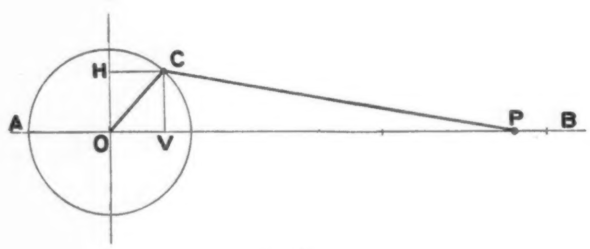


FIG. 2.

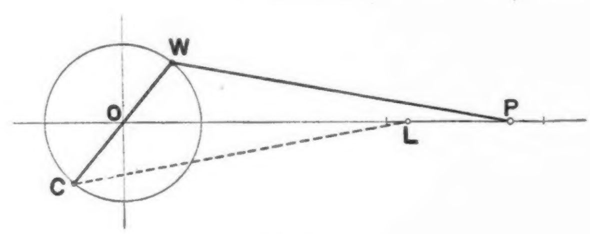


FIG. 3.

There is one more elementary statement to make, namely, that a weight of W pounds at a radius 2r has the same effect as a weight of 2W pounds at a radius r; this follows immediately from the value of the centrifugal force $\frac{M V^2}{32.2r}$, for with the same number of revolutions V is proportional to r, so that for equal forces Mr must be a constant. For simplicity, therefore, all balance weights will be assumed to be placed at the same distance from the center as the crank pin.

With these facts in mind, let Fig. 3 represent an ordinary engine, and let all the rotating weights be concentrated at the

* Presented before the September meeting of the Canadian Railway Club.

crank pin W, say 1000 lbs.; let the reciprocating weights be concentrated at the crosshead at P, say 1500 lbs. The rotating weight can be balanced by a weight of 1000 pounds placed at C, diametrically opposite W on the other side of the center; evidently, whatever be the position of the crank, the forces caused by the two weights are equal and opposite, and there is no resulting force to disturb the axle at O.

When, however, attempting to balance the 1500 lbs. at P, by placing 1500 lbs. at C, the condition is entirely different; the horizontal forces caused by the movement of P are exactly equal and opposite to those caused by the 1500 lbs. at C, but as no vertical forces are caused by P's movement, the vertical forces caused by the movement of the 1500 lbs. at C are left entirely unbalanced, and the effect is the same as though a weight of 1500 lbs. at C were entirely unbalanced vertically. Whatever weight then is introduced at C to balance the horizontal forces caused by P, causes vertical forces equal in amount to the extent by which those due to P are reduced; there is no possible combination by which this can be avoided, except by using crank pins that are not at right angles to each other.

For instance, if there was a crank pin at C and a connecting rod as shown by the dotted line CL, then if the weights at L and P were in substantially the same plane and equal, they would practically balance each other, as is the case with four-cylinder engines, which can be almost perfectly balanced without introducing any vertical forces, while three-cylinder engines can be balanced longitudinally, but are, with respect to nosing, almost in the same class as two-cylinder engines. The latter are the engines now under consideration, and in their case the question of counterbalancing is a compromise. If P is left unbalanced the engine is said to be badly balanced, if P is completely balanced the engine is said to be well balanced, but vertical forces are introduced which certainly may be injurious to track or bridges.

The extent of the force due to any unbalanced weight may be calculated at any speed, but is usually taken at 40 times the weight when the speed in miles per hour is equal to the diameter of drivers in inches; it really varies with the stroke, and the exact figures are 38.5 for a 24" stroke, 41.7 for a 26", and 44.9 for a 28"; taking 40 for an approximate figure, 500 lbs. at C above that required to balance the rotating weights, or, as it is termed, "as overbalance," means a force of 20,000 lbs. acting upwards and downwards at each revolution, and while this seems a high figure, it is occasionally found.

The speed of 69 miles per hour is high for a 69" wheel, but it represents a possible condition, and it must be remembered that while the factor of 40 is not reached until that speed for that size of wheel, that it increases with the square of the speed, so that it is not advisable to consider a lower speed. Evidently, then, it is desirable to keep the overbalance as small as possible, and yet on the other hand the reciprocating parts must be partially balanced for the comfort of the men, and the various rules of counterbalancing have really indicated the nature of the compromise.

The rule most commonly used in America has been that recommended by the committee on the subject at the M.M. Convention in 1882, in which two-thirds of the reciprocating parts are balanced; this compromise has, on the whole, given very satisfactory results, and constituted a great advance on one of the methods given as an answer to the inquiry made by the committee, which was "to figure a little and then guess at it." The two-thirds rule, however, is not necessarily satisfactory; it proves so in the majority of cases, because the relations between the weight on drivers, weight of engine, and reciprocating parts do not vary greatly in engines of ordinary types, but the first great advance was made when G. R. Henderson, in a report made to the Norfolk and Western Railway, in 1895, pointed out that the allowable weight of unbalanced reciprocating parts was a factor of the weight of the engine.

Assuming only, that the maximum speed is proportional to the diameter of the drivers, and that it is desired to construct engines that will be reasonably comfortable for the men at that speed; in other words, that will vibrate to the same amount, then evidently the disturbing forces, or the weights of the unbalanced parts, may vary in direct proportion to the weight of the engine. Mr. Henderson showed that engines in which 1/400 of the weight of the engine was unbalanced rode satisfactorily, and that 1/360 can be left unbalanced without objectionable vibration; we have then in this rule a scientific method of determining the weight of reciprocating parts that may be left unbalanced, and yet allow the engine to ride reasonably well, which is applicable to engines of widely varying types; for instance, if two engines were of the same weight, but one had reciprocating parts weighing twice as much as those on the other, this rule would allow the same weight to remain unbalanced; in other words, both engines would ride equally well, whereas with the old two-thirds rule one engine would have twice as much unbalanced weight as the other.

So far as the action of the engine is concerned, there is, I consider, no criticism possible that can be made of this rule; in other words, an engine balanced by it is certain to ride satisfactorily, but in balancing an engine there is another and very important aspect of the matter which it ignores, namely, the effect of the overbalance on the track. This side of the question has often been referred to, and its effect discussed in a general way, but so far as I am aware, locomotive builders have never really established any rule limiting its amount, although they have recommended balanced compound engines or the utilization of the weight of the tender, which I shall refer to later. On the other hand, no maintenance of way engineer has, I believe, defined the limit of overbalance which he considers permissible, although he will cheerfully advocate none being used; neither is he able, except in extreme cases, to show any definite evidence of damage from this cause. Taking, however, the maximum speed before referred to, an overbalance of 500 lbs. in a wheel carrying 20,000 lbs. causes the pressure between that wheel and the rail to vary from 40,000 lbs. when its overbalance is down, to nothing, when it is up, and any greater overbalance would tend to lift the wheel from the rail.

Testing plant experiments show that when the calculated effect of the overbalance exceeds the weight on the wheel that it does actually leave the rail, and that there is a definite blow when it strikes it again. I have analyzed this action (see AMERICAN ENGINEER AND RAILROAD JOURNAL for February, 1909), and have shown that this blow may, in extreme cases, be severe and sufficient to account for the damage that is occasionally met with; on the other hand, I do not believe that any case of repeated bending of rails has occurred in which the vertical effect of the overbalance did not considerably exceed the weight on the wheel. It is, however, only reasonable to acknowledge that a wheel that presses alternately nothing, and 40,000 lbs. on the rail, is going to affect the track more than one which presses down continuously with 20,000 lbs.

It will damage more defective rails, cause more injury to tracks, and may, in weather when the rail is unevenly supported, be the cause of rail breakages. From the track point of view, therefore, the less the overbalance the better, and the problem of the locomotive engineer is to determine to what extent it can possibly be reduced. To discuss this I must refer more in detail to the action of the unbalanced weights on the engine. In Fig. 4 let P_1, P_2, be the right and left crossheads respectively, C_1, C_2, the crank pins, and O_1, O_2, the overbalances; as C_2 and O_1 are in the middle of the stroke they have no horizontal effect, and there is a longitudinal force equal to $P_1—O_1$ tending to drive the right side of the engine backward; as P_2 comes to the end of its backward stroke there is a similar force tending to draw the left side of the engine backward, and at that time the effect of P_1 and O_1 is nothing. This action is repeated at the other end of the stroke, so that the action of the unbalanced weight is to drive the engine backwards and forwards as a whole, and also to cause the ends of it to vibrate transversely; or, as it is usually called, "make it nose."

There are then two distinct actions of the unbalanced weight in an engine, which I will call the longitudinal and transverse movements; the latter you will agree, I believe, is not generally

very noticeable, but on small 8-wheel engines it is objectionable when running at a high rate of speed. Some years ago, when working on this subject, I noticed, as I dare say you have, that on the longer, heavier engines, the nosing from unbalanced weights was not noticeable, and in a paper before the Northwest Railway Club, in 1896, I advocated a rule in which the unbalanced weight was increased in proportion to the length of the engine as well as to its weight. This rule was defective, as it increased the longitudinal vibrations on a long engine as compared to a shorter one of equal weight, and as the longitudinal vibrations are those which render an engine rough riding, it could not, and no rule could increase the unbalanced weight beyond a certain amount without being objectionable. It is true

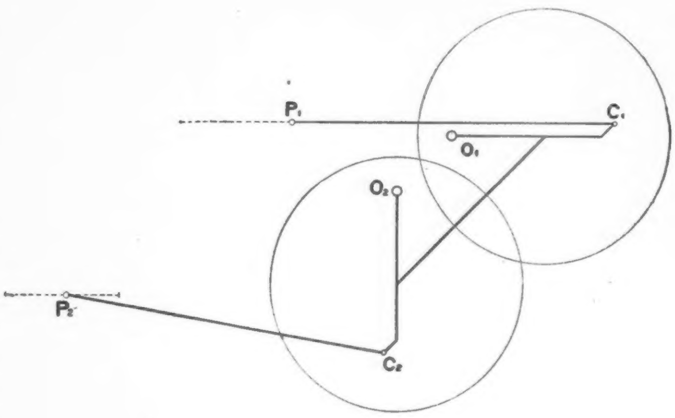


FIG. 4.

that engines balanced by it rode satisfactorily, but that was because it started with a short engine with 1/400 of the weight unbalanced, and on the longest engines it was applied to, did not increase the unbalanced weight beyond 1/360, which is an amount that does not, as a rule, lead to criticism by the men.

Although this rule was not of much practical value, it recognized one point, namely, that the nosing motion was not as important as the longitudinal, and when investigating the counterbalancing of some engines on the Canadian Pacific, in which the counterbalances were offset so as to increase the longitudinal and decrease the nosing movement, it occurred to me that by allowing an increase in the nosing movement, a decrease in the amount of overbalance could be obtained without increasing the longitudinal movements.

This can be done by means of offset counterbalance weights, but as they have a serious objection, the same result can be obtained by means of supplementary counterbalance weights placed at right angles to the cranks. This arrangement is shown on Fig. 5, S_1, S_2, indicating the supplementary counterbalances and the arrows the direction of the forces.

Neglecting the difference in the distances, center to center, of the balance weights and the pistons, which it is not necessary to consider here, it will be seen that the forces at O_2 and S_1 both tend to drive the engine forwards as against that of P_2 driving it backwards; in place of a force $P_2—O_2$ driving it backward as in Fig. 4, the force is, therefore, reduced to $P_2—(O_2+S_1)$, on the other hand, the force $P_2—O_2$ still tends to throw the front of the engine to the right, and it is assisted by S_1.

The net result therefore is, an engine that is balanced longitudinally as an engine would be with an overbalance O_2+S_1, and balanced transversely as though its overbalance were $O_2—S_1$. To put this into figures, suppose the engine weighs 160,000 lbs., and the reciprocating parts weigh 1300 lbs. a side; the permissible unbalanced weight at 1/400 of the weight is 400 lbs., leaving 900 lbs. to be balanced, or 300 lbs. per wheel, if the engine has six drivers; if the weight per wheel is 20,000 lbs., this overbalance is 1.5% of the weight on the wheel, and the variation in pressure at the maximum speed is 12,000 lbs., or 60%.

This would not be an unusual case, in fact it would be an ordinarily well-balanced engine. Now, if we place a supplementary balance weight of 100 lbs. on the opposite wheel, and reduce the overbalance to 200 lbs., this 200 lbs., and the 100 lbs. from the other wheel, make up the 300 lbs. to balance the engine longitudinally, but for transverse balance the 100 lbs. has to be deducted from the 200 lbs. overbalance, so that only 100 lbs. is balanced in each wheel, or 300 lbs. altogether.

Taking 300 from 1300, leaves 1000 lbs. unbalanced transversely, or 1/160 of the weight, and we, therefore, have an engine that longitudinally has 1/400 of its weight unbalanced, but transversely 1/160 unbalanced. The overbalance has been reduced from 300 to 200, but the reduction in the effect on the track is not quite as great as this; the greatest effect of S_2 and O_2 is not when O_2 is vertical, but it equals $^2\sqrt{(O^2_2+S^2_2)}$ or, for the two weights in question 222 lbs., a reduction of 78 lbs., or 3120 lbs. at the maximum speed.

I am not entirely prepared to say how far this system can be carried, but from the experiments so far, it would appear that an engine having 1/400 of its weight unbalanced longitudinally, and entirely unbalanced transversely, is entirely satisfactory as far as its riding qualities are concerned. This would mean that the supplementary balance was equal to the overbalance, and in that case the effect on the track would be 71% of that of an ordinary overbalance giving the same longitudinal effect, and this reduction can be accomplished without detriment to the ordinary qualities of the engine, or without introducing any objectionable troubles.

It is true that the nosing must be prevented by the pressure on the hubs of the wheels, but against this, it must be remembered, that when balance weights are distributed amongst three or four wheels that the effect of the overbalance on the boxes of all except the main wheels is just the same as it is on the track, and that the steadying effect on the engine is obtained at the expense of wear in the boxes. The wheel base on an engine is so long, compared to the distance from the center of the engine to the center of the cylinder, that a very small pressure on the hub is able to overcome a nosing motion much better than a balance weight, and probably with less wear.

We are not, however, leaving engines entirely unbalanced

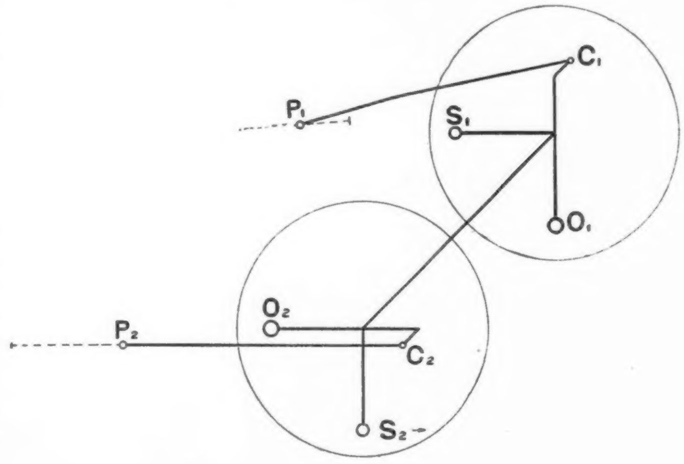


FIG. 5.

transversely except as an experiment, but are leaving from 1/100 to 1/150 of the weight unbalanced transversely, and 1/400 unbalanced longitudinally with extremely satisfactory results; one passenger engine has been entirely balanced longitudinally and entirely unbalanced transversely. It is reported to be a "perfect riding engine," and its balance is exactly the same as a 3-cylinder engine having two outside cranks each at right angles to the inside crank, and otherwise unbalanced, so that it has been shown that an engine of this kind would be entirely satisfactory as far as the balancing is concerned.

We are, however, using the system of balancing to reduce the action of the overbalance on the rail, and have adopted a rule to balance the engine so that the overbalance in any one wheel shall not, if possible, exceed 1% of the weight on that wheel, and is limited to 1¼%.

The latter figure causes a variation of 50% of the weight on the wheel at the maximum speed, and while I have, of course, no accurate information to show that this is the proper limit, it is so much better than on many existing engines, that I feel that it is a sound limit to work to, and we are certain that under no conditions can any hammer blow occur from wheels balanced in this way. So far, no engine has been met with in which it is not possible, by using supplementary balances, to obtain satisfactory results, without increasing the overbalance above this amount.

There are also one or two practical advantages in the system of allowing a greater unbalanced weight transversely. It is possible to properly counterbalance consolidations, as the supplementary weights can be placed in the wheels at right angles to the crank, thus overcoming the difficulty experienced of not being able to get sufficient balance opposite the crank without an excessive overbalance in the leaders and trailers.

It makes the adjustment of the balance very easy. It is only necessary to cast the main balances 75 or 100 lbs. light, and then place 75, 100 or 125 lbs. in the supplementary balance, as is necessary to keep the longitudinal unbalanced weight down to 1/400 of the weight of the engine. Extreme accuracy is entirely unnecessary, any engine that has less than 1/400 unbalanced longitudinally will ride well, and apparently, the transverse balancing is very unimportant.

The weights should be checked up to see that the effect of the

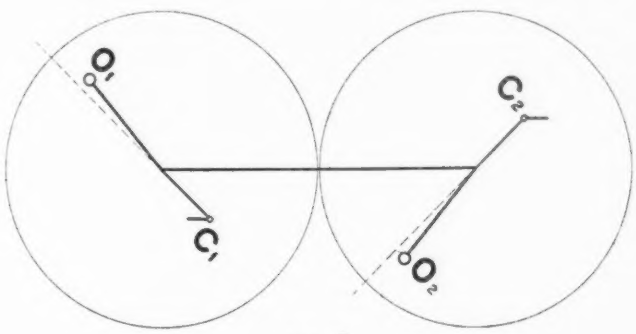


FIG. 6.

overbalance and supplementary balance is less than 1¼% of the weight on the wheel, but this is fairly well known from corresponding engines, and in the types so far gone into, there has been no case where this figure had to be exceeded.

These advantages are, of course, incidental, the chief interest is, I consider, the fact that an engine may be unbalanced transversely to a far greater extent than longitudinally without causing its riding qualities to be objectionable, consequently, the overbalance can be reduced, and its effect on the track maintained within reasonable limits.

I have referred to the utilization of the weight of the tender. This has been done on the Prussian State Railways by coupling the engine with tender so firmly that the weight of the tender assisted in absorbing the longitudinal vibrations. If this could be done the factor of 1/400 could, of course, be applied to the total weight of the engine and tender, and I understand that engines have run with the reciprocating parts entirely unbalanced with satisfactory results.

We have always found here that when less than 1/360 was unbalanced, trouble has developed in keeping up the connection between engine and tender, and lost motion has occurred very quickly. I feel that, with our heavy reciprocating parts and hard service, this method is hardly practicable, and it does not afford any hope of being able to avoid some system of balancing for two-cylinder engines.

Before closing, I wish to refer to offset counterbalances, as it is obvious that the combination of main and supplementary balances I have described is the same as an offset balance weight; the trouble with the latter is that it cannot be weighed, and must be calculated.

Some very serious errors have been introduced by depending on weighing it, especially where it is offset, to reduce the nosing movement; in Fig. 6 let C_1, C_2, be the crank pins, O_1, O_2, the counterbalances (not only the overbalances); when weights are placed on the crank pins at C_1, they do not show the weight of the overbalances at O_1, as is the case with an ordinary balance opposite the crank; suppose the crank pin radius be 12" and the counterbalance O_2 is set 4" off the center line; evidently the weight at C_1 acting at 12" is helped by that at O_2 acting at 4", and the mistake has been made of thinking this weighed the counterbalance at O_1; it does not begin to.

O_1 in addition to balancing the weights at C_1, is balancing the entire weight of the crank pin and hub, and a numerical example will show what happens. Suppose O_1 is also 12" from the center, and that the weight of the crank pin and hub at C_1 is 500 lbs., and that the counterbalance desired is 400 lbs. Neglecting the fact that O_1 is not quite 12" from the vertical line, it would require 900 lbs. at O_1 to give a counterbalance of 400 lbs. in addition to balancing the weight of the hub; this 900 lbs. would also act at O_2 at a distance of 4" from the center line, and consequently the weight required at C_1 to balance would be $\frac{900 \times 12 - 900 \times 4}{12}$ or 600 lbs., of which 500 lbs. is supplied by the crank pins and hub, leaving only 100 lbs. actually necessary to balance an overbalance of 400 lbs.

Evidently, this might easily be very misleading, and the difficulty is that, from the weight on the crank pin the actual overbalance cannot be calculated except by estimating the weight of the crank pin and hub, and knowing the exact offset of the center of gravity of the counterbalance.

For this reason the arrangement of counterbalance weights directly opposite the pin is far better, as they can accurately be weighed and the supplementary balances of known weight afterwards added.

Fuel Economy.—The greatest waste of our coal supply is in our imperfect processes for rendering available its latent energy. In the average power plant not over ten per cent. of the potential energy of the coal is utilized. About one-quarter of our total coal consumption is in locomotives, and the loss due to boiler scale is probably at least 15,000,000 tons. The advent of the gas engine and producer gas has marked a long step in advance, for not only can the percentage of coal energy utilized be raised to 18 or more, but, what is even more important, low-grade coals, such as lignites and some peats, become available. On the other hand, gas producers do not work very satisfactorily with bituminous coals, particularly those of the coking variety. Using small anthracite, producers will consume from one to one and a half pounds of coal per horse-power hour, while steam boiler plants require 2 to 3 pounds for large plants, and 4 to 8 pounds in very small plants. In plants of 300 h.p. or less, the same coal will generally give about 2½ times as much power in a gas engine as when burned under a boiler. In large plants (20,000 h.p. and over), the saving in fuel by the gas engine is largely offset by its greater cost of installation and maintenance.—*M. T. Bogert, Presidential Address, American Chemical Society.*

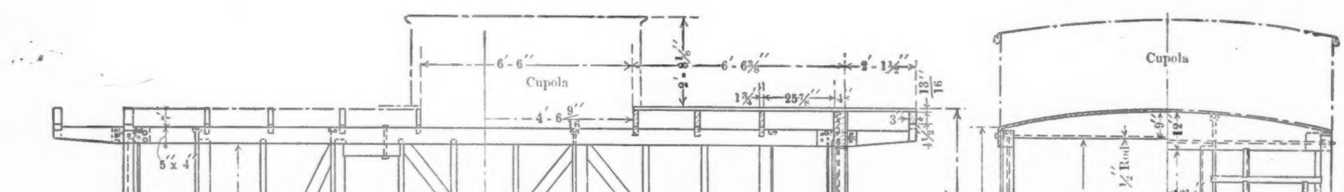
American Exposition in Berlin.—An American Exposition will be held in the city of Berlin, Germany, during the months of April, May and June, 1910, in the Exposition Palace, located in the best and most frequented part of the city. It is intended to educate the European, especially the German population, to the importance and excellence of American manufactured products, and thus to strengthen the existing cordial relations and to stimulate trade between the two countries. The exhibits will be limited to articles of proven merit, and in order to make the exposition of the greatest possible permanent benefit to both nations, the American advisory committee is desirous of having prominent American firms represented in every line. To encourage prospective exhibitors to this end, exceptional facilities will be offered them. Information may be obtained by addressing Max Vieweger, American manager, at the Hudson Terminal Buildings, 50 Church street, New York City.

CABOOSE.

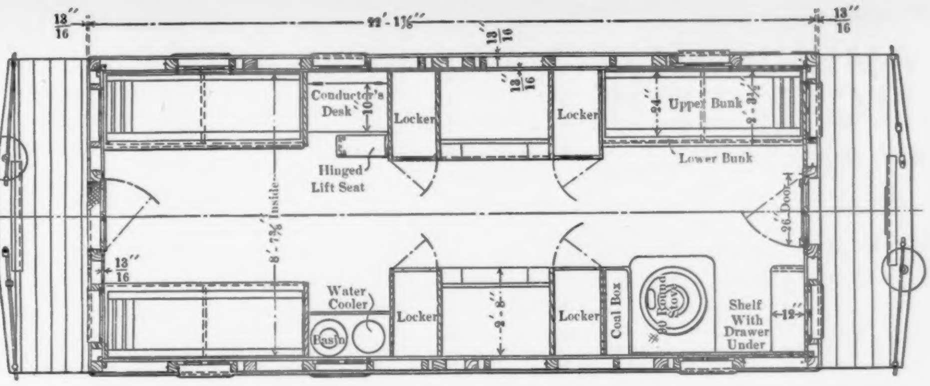
VIRGINIAN RAILWAY.

The Virginian Railway has recently placed in service a number of cabooses that were designed for use on the mountain divisions where Mallet compound locomotives, having a tractive force of 80,000 lbs., are used for pushing. The underframe is made unusually strong, the center sills and draft gear being the same, as far as conditions will permit, as those on the steel coal cars on that road. In a rear end collision one of these cabooses was not damaged although an ordinary caboose under the same conditions would have been completely wrecked. The center sills are 15-in., 40-lb., channels; they are covered with a 5/16-in. plate 20 in. wide and are reinforced at the bottom, between the bolsters, by 3½ x 3-in. angles. They are tied together, between the bolsters, by three pressed steel diaphragms and are connected to the wooden side sills by ¾-in. rods and 4 x 8-in. timbers, as shown.

The bolsters are built up of pressed steel members between



DETAILS OF CABOOSE WITH STEEL UNDERFRAME, VIRGINIAN RAILWAY.



FLOOR PLAN OF CABOOSE—VIRGINIAN RAILWAY.

the center and the side sills and a steel casting between the center sills. These are tied together by top and bottom cover plates. Westinghouse friction draft gear is used with Farlow attachments. The upper framing and the arrangement of the floor plan are clearly shown by the drawings. These cabooses were designed under the direction of R. P. C. Sanderson, superintendent of motive power, and were built by the American Car & Foundry Company at Wilmington, Del.

COST OF OPERATING COALING STATIONS.

A committee on "Standard Types of Coaling Stations," in presenting its report to the International Railway Fuel Association, gave some figures showing the comparative cost of operating different types of coaling stations. The statement includes several examples of eight different types, located on various roads in different parts of the United States, suggesting variable climatic conditions and labor costs. In order to secure a more representative comparison, the average of a number of stations of the same type is given rather than items showing individual station figures, the results covering a twelve months' period. The figures do not include the items of general supervision, insurance, taxes or charge for locomotive service in placing cars for unloading.

TYPE	COST OF INSTALLATION	INTEREST ON PLANT AT 5%	DEPRECIATION ON PLANT AT 5%	MAINTAINANCE	SUPPLIES	LABOR	TOTAL COST	TONS HANDLED	AVERAGE COST PER TON
1	$136,848.38	$6,842.27	$6,842.27	$1,633.92	$420.55	$59,756.93	$75,495.94	710,735	$.1062
2	150,556.12	7,527.77	7,527.77	2,404.62	1,652.84	17,724.86	36,837,86	610,041	.0604
3	91,777.45	4,588.86	4,588.86	2,114.95	135.22	13,128.42	25,556.31	471,103	.0542
4	94,000.00	4,700.00	4,700.00	720.00	289.16	21,595.44	32,004.60	296,232	.1080
5	4,686.42	234.31	234.31	239.71	72.68	5,236.15	6,017,16	33,505	.1795
6	114,552.90	5,727.60	5,727.60	5,026.41	3,502.99	17,359.18	37,343,78	698,988	.0534
7	66,364.06	3,318.20	3,318.20	200.40	1,077.64	10,970.49	18,884.91	267,226	.0706
8	30,500.00	1,525.00	1,525.00	480.00	2,068.08	9,903.24	15,501.32	250,992	.0617

Type 1.—Twenty-five Chutes—Shoveling chutes, inclined trestle served by locomotives; chutes located in Mo., Texas, Ala., Miss., Minn., Ia., Kas., Okla., Ark., Ind., Ky., Tenn., on lines of M. K. & T., Frisco., Rock Island, C. & E. I., Penn. R. R., and Queen and Crescent System.

Type 2.—Fourteen Chutes—Gravity chutes, timber construction, using self-clearing cars. Served by locomotives and gasoline or electric cable hoist. Chutes located in Kas., Tex., Okla., Mo., Miss., Ala., Ark., Ill., Ia., on lines of the M. K. & T., Rock Island, Frisco., and C. & E. I. R. R.

Type 3.—Nine Chutes—Holman type, using one to four balanced buckets with capacity of one to three tons each. Chutes located in Ill., Ia., Mo., Ark., Okla. and Pa., on M. K. & T., Frisco, Rock Island, Penna. R. R. and C. & E. I. R. R.

Type 4.—Eight Chutes—Trestle platform, one ton or more capacity buggies. Gondola and covered cars placed by locomotives. Chutes located in Ky., Tenn. and Ala., on Queen and Crescent System.

Type 5.—Six Chutes—Air hoist, crane and buckets, air pressure furnished by locomotive taking coal. Located in Tex., Kas., Ia., Minn. and Ind., on lines of Penna. R. R., M. K. & T. and Rock Island.

Type 6.—Seven Chutes—Bucket conveyor type, using gasoline, steam and electric power. Self-clearing cars employed. Located in Ia., Kas., Ind., Mo., Ohio and Tenn., on lines of M. K. & T., Penna. and Rock Island.

Type 7.—Three Chutes—Inclined conveyor, rubber or canvas belt, gasoline, electric and steam power. Self-clearing cars used.

Type 8.—Four Stations—Locomotive crane and clamshell, gondola cars used. Located in Ill., Mo., Okla. and Tenn., on lines of Frisco and Queen and Crescent System.

Pulleys should be 25 per cent. wider than the belts running on them.

Basing Fuel Contracts on Amount of Ash.—It is believed that fuel contracts should be based on a stipulated amount of ash, with penalties for an excess and premiums for reductions. This system would have the effect of encouraging operators to provide better facilities and employ the best means of preparation. The railroads would profit by reducing the haulage of inert material and the cost of handling the coal and [illegible] While the expense of analysis may seem excessive, it wou[illegible] the assurance that fuel inspectors are not discriminating [illegible] or favoring certain operators, and with this information [illegible] the officials in charge of locomotives could insist upon [illegible] results. Enginemen will often resort to the excuse that poor coal was responsible for a delay, believing that it is the simplest method of preventing trouble for themselves, or shielding other parties. Engine troubles occur more frequently during the busy period, because they are of more importance at that time, and are, therefore, noted more carefully.—*From Committee Report on "Difficulties Encountered in Producing Clean Coal for Locomotive Use" before The International Ry. Fuel Assn.*

Railroad Y. M. C. A.—The work of the railroad branches of the association located on our lines, the influence they exert, the accommodations they afford our employees, have, in my opinion, been of very distinct benefit in improving the character and morale of the service; and the contributions of the railroad company to these associations have been among the most profitable investments the roads have made.—*W. C. Brown, President, New York Central Lines.*